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Devoted to Commercial and Naval Motor Vessels

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OUR DIESEL MARINE ENGINES
MAKE SHIPS EFFICIENT

McINTOSH & SEYMOUR CORP.
AUBURN, N.Y. U.S.A.

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EXCLUSIVE technical and non-technical articles on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.

MOTORSHIP

PROFUSELY illustrated with photographic reproductions of the newest designs in international merchant motorship and Diesel-engine construction and auxiliary equipment.

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Munson Line's Fourth Motor Tug

"Munjuan," a Fairbanks-Morse Oil-Engined Tow-Boat, for Cuban Service

IN keeping with the most progressive policy which the Munson Steamship Line of New York has adopted in the selection of oil-engine power is their recent addition of a fourth Fairbanks-Morse oil-engined tug to their fleet. Not only has this important domestic ship-operating company headed by Frank C. Munson consistently operated tugboats powered with oil-engines rather than steam, in line with Mr. Munson's belief in and advocacy of the Diesel-engine, but this company has also purchased McIntosh & Seymour Diesel-engine and is installing them in two steel steamers which they have purchased from the Shipping Board.

The organization of the Munson Steamship Line is composed of progressive men who keep pace with Mr. Munson and give him the technical advice and data which is needed to properly consider the Diesel and the oil-engine question from a proper unbiased standpoint. Alfred J. C. Robertson, naval architect, and John H. Telford, marine superintendent, keenly appreciate the advantages of oil-engine power in the marine field and in such an organization it is not surprising that four tugs and two coastwise motor cargo-vessels are either in commission or will soon be.

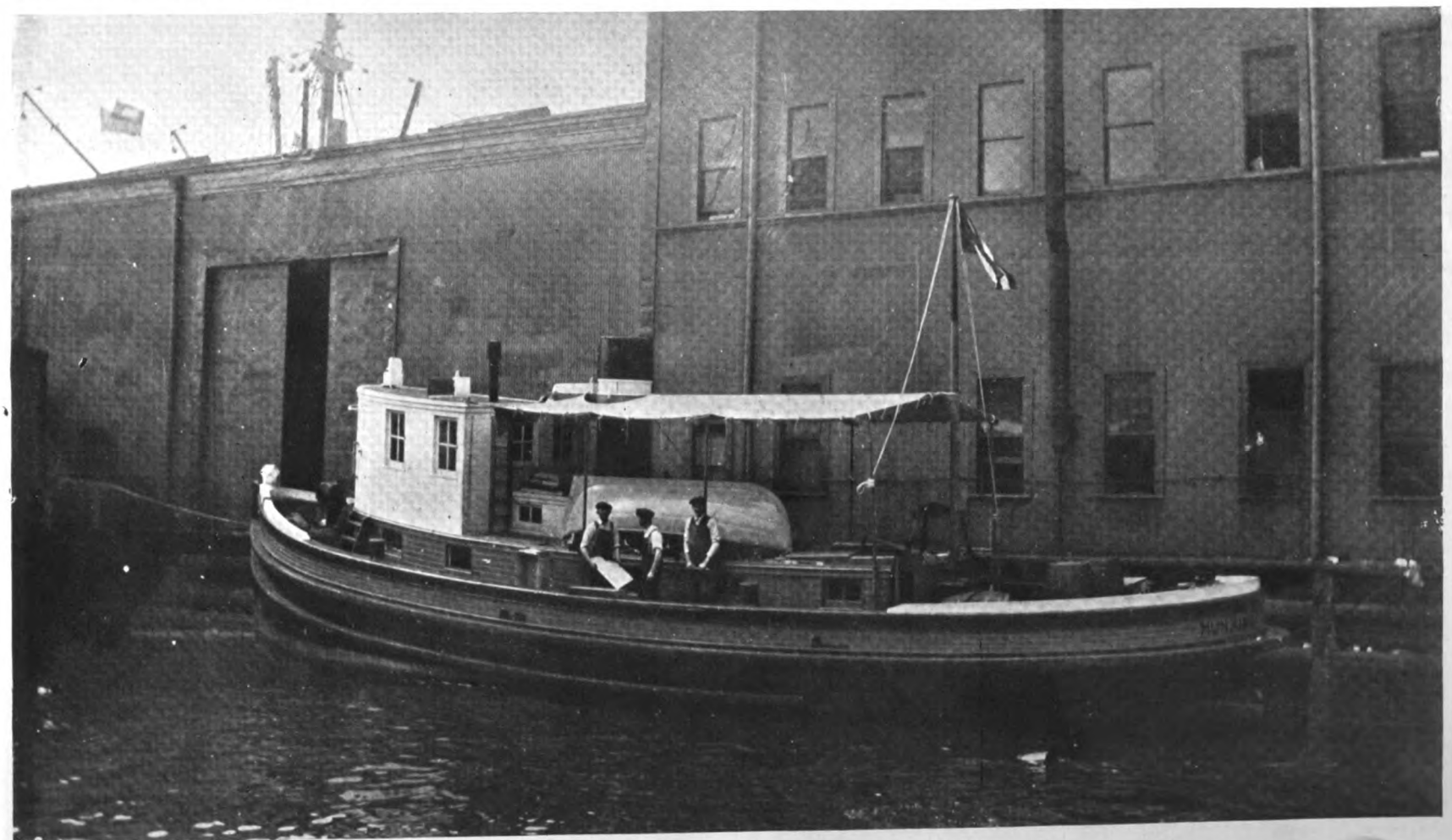
About the middle of September there left New York for duty in Cuba, flying the flag of that country, the new Fairbanks-Morse-engined tug MUNJUAN which is the latest addition to the fleet of the Munson Steamship Line. This tug shows the possibilities in the use of the hulls of Shipping Board tugs, some of which are still available. She was formerly a new tug hull which had been built by the Vinyard Shipbuilding Co., of Milford, Del., for the Board and which was purchased by the Munson Line before the deck houses had been erected.

The Munson Line then contracted with the New York Harbor Dry Dock Co., of Staten Island, to complete the tug—the work being completed in 28 days at a moderate cost. The MUNJUAN has the following dimensions:

Length	60 ft.
Breadth	22 ft.
Draft	7 ft.

It will be noted from the plans that amidships there is a section of the main deck extending across the ship, the usual practice in small steam tugs where the boiler is to be installed forward and the engine aft of this 'thwartship deck. A 100 h. p. four-cylinder Fairbanks-Morse oil-engine is fitted forward of this deck, utilizing the latter as a foundation for daily service fuel-tanks and lubricating-oil tanks. The space at the after end of the house has been utilized for engine-room supplies, crew's toilet, tank, etc. Forward is a gallery with a Shipmate range and pilot-house. As the crew of this boat will sleep on deck in the warm Cuban climate the top of the cabin over the engine-room has been left practically clear and an awning placed over same.

The engine-foundations were constructed extremely heavy and well fastened, all bolts coming through the planking and having the heads flushed over a felt-washer, painted with red lead and covered with sheet-lead fastened by copper tacks. The tail-shaft and intermediate-shaft are of very liberal diameter provided with a bronze liner at stern bearing and stuffing-boxes, the former being bushed with lignum-vitae and the latter lined with white metal. Between the liners at bearings the shaft is coated with bitumastic and covered with a lead-sleeve soldered to the liner. A Columbian bronze propeller of 50" diameter and 36" pitch provides the boat with a good towing speed. This tug will be used for the greater part of the time in handling scows and lighters and may occasionally be used in docking steamers.



The "Munjuan" at the Munson Line Pier, East River, New York

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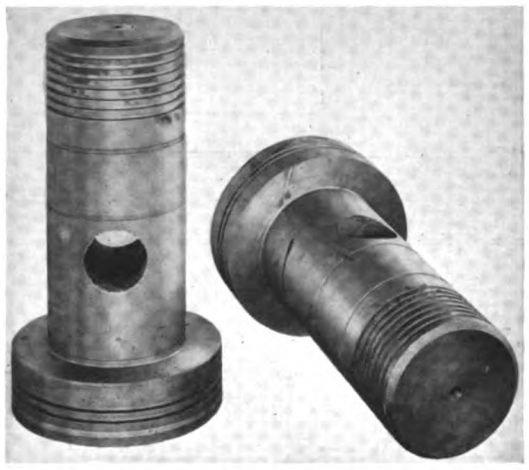
New Stepped-Piston Airless-Injection Engine

First Details of the Adams Heavy-Oil Marine Engine Installed in the Coastwise Vessel "Gryme" — An American Production for Work-boats



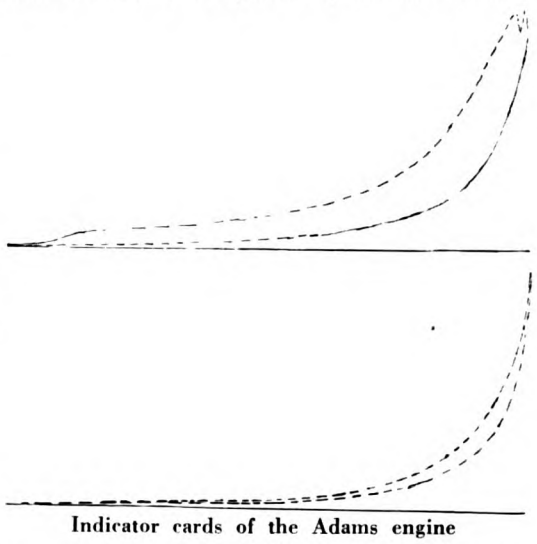
Pistons of Adams engine showing step for the scavenge pump

INCREASING demand for oil-engines of moderate power is causing several additional domestic manufacturers to enter this field where there now is so much activity. This is in striking contrast to activity in other branches of the marine internal-combustion engineering field and is the direct result of the increased use of fuel heavier than gasoline, kerosene and distillate. The lower cost of this heavier fuel, as well as better fuel-economy of the Diesel and surface-ignition types of engine, are responsible for this increased use. As has been often mentioned in our pages, much of this activity is on the Pacific Coast of this country, where it is necessary that engines successfully operate on low-grade asphalt base fuel-oils of the Californian and Mexican oil-fields on long runs, generally in the hands of inexperienced operators, and with but little attention from skilled engineers. While owners in many sections of the country would like to operate their boats under these conditions, the Pacific Coast usually has no option; it must have engines which will operate under these adverse conditions.

Primarily designed with these local conditions in mind, but with the entire market in view as well, a new direct-reversible two-cycle, airless-injection, stepped-piston type of Diesel-engine has been produced by E. T. Adams & Sons of Los Angeles, Cal., the constructural work being carried out by the Madsen Iron Works of the same city. A study of the accompanying illustrations reveals care in design, sturdy construction, simplicity and convenient arrangement. However, many features differentiate it from the usual design of two-cycle oil-engine, one being the use of a flat-top piston, all deflectors having been eliminated, this being possible by the arrangement and timing of the air-ports, which system has worked out satisfactorily.

Another feature of this Adams engine is the use of an excess of scavenge-air with a view to producing better scavenging and more complete combustion of the fuel. This scavenge-air is compressed in the chamber formed by the step, or enlarged lower section, of the piston and cylinder and not separately driven scavenge-pumps or by crank-case compression, with a view to eliminating poor combustion and waste of lubricating-oil.

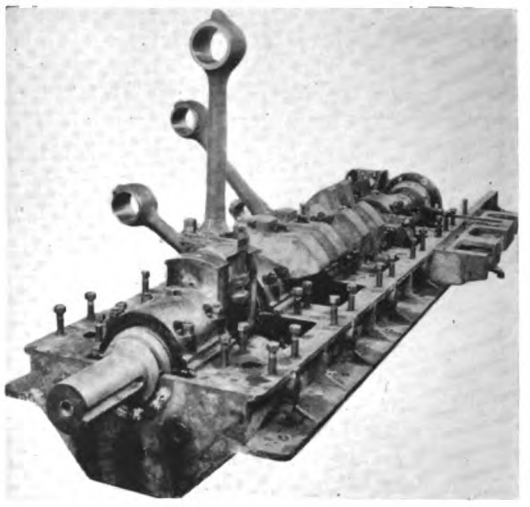
One illustration shows the piston clearly, and the scavenge-air is compressed at low pressure in the area above the lower step, both inlet and outlet of the air being controlled by valves. Scavenge-air being compressed in each cylinder for use in that same cylinder facilitates building the engine in any desired number of cylinders, but the custom-



Indicator cards of the Adams engine

ary step-piston design arranges for one cylinder to scavenge the adjacent cylinder, with a connecting air receiver.

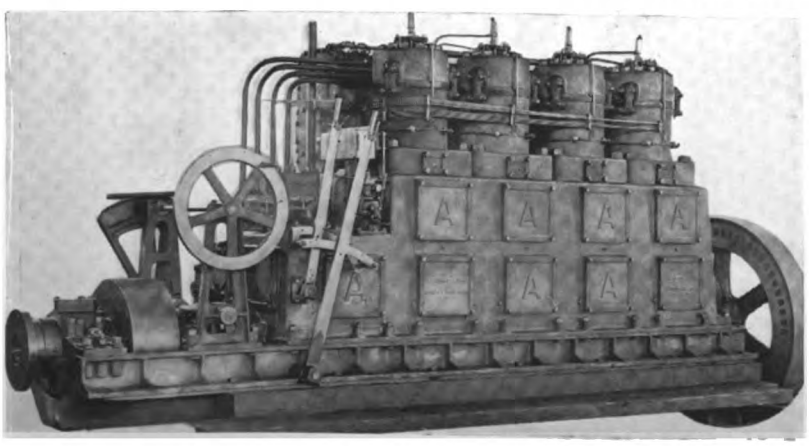
Fuel-injection, which occurs practically at dead-centre, is accomplished by mechanical-atomization rather than by vaporization of the fuel by means of heat. In order to provide a system which should require minimum attention and avoid clogging of the valves the fuel-pump pressure is moderate and the spray-valve opening is large. It is possible to obtain fine atomization under these conditions, but not to obtain fine atomization plus high velocity of the atom. Therefore, in order to control the initial stages of combustion and obtain flexibility, the fine spray is led into a primary chamber where, even at low velocity, it will easily penetrate and here, entirely independent of the load on the engine, the rate of combustion may be controlled. In this small chamber a thorough mixture of the fuel and air is possible and complete combustion is attained within the engine cylinder with a wide range of fuels and without requiring too delicate control of either the time or the rate of injection. The accompanying indicator-cards taken at friction and average-loads show the results obtained with this system of injection.

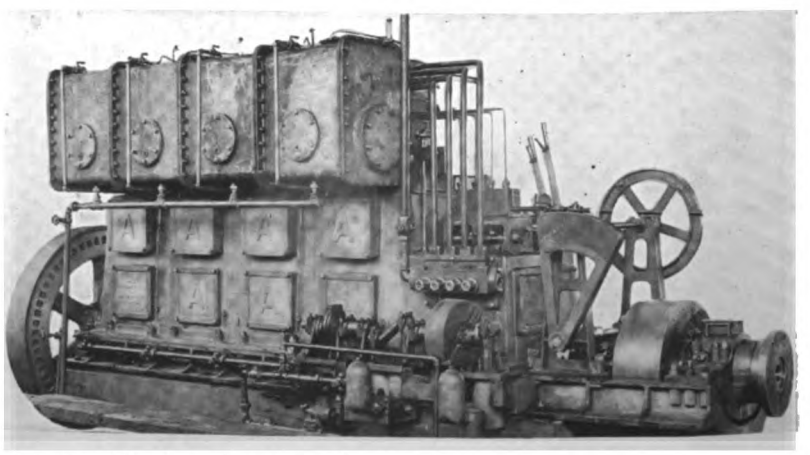


Bed plate, main bearings, crankshaft and connecting-rods being assembled

The frame and sub-base follow conventional practice, forming a rigid truss which should withstand any stresses ever likely to be placed upon it. A horizontal plate extending over the entire length of the frame divides it in two parts, the lower portion being the crank-case reached through the lower series of hand-hole plates, while above are the scavenging-air receivers and the light steel-plate air-valves reached through the upper row of plates. At the after end of the engine is an extension of the frame to house the governor, fuel-oil injection cams, air-starting distributor, and a single-stage air-pump for the maneuvering air. All the operating-mechanism for these parts is enclosed within the casing, where it runs in oil, with adjustments and connections for piping outside where they are immediately accessible.

The working cylinders are separate units centred on the lower air-compressing cylinder, the latter formed by a hard steel removable liner pressed into the frame, the lower step of the piston working in this cylinder. Four large bolts hold the cylinder in place and it is easy to remove either cylinder or cylinder head; the latter is symmetrical and thoroughly water-cooled. In engines of 250 h.p. and less the cylinder is easily handled by removing four nuts and lifting the cylinder about six inches, giving instant access to both air and working-cylinders, piston, piston-pin and





Starboard and exhaust sides of the new Adams airless-injection Diesel marine engine for work-boats

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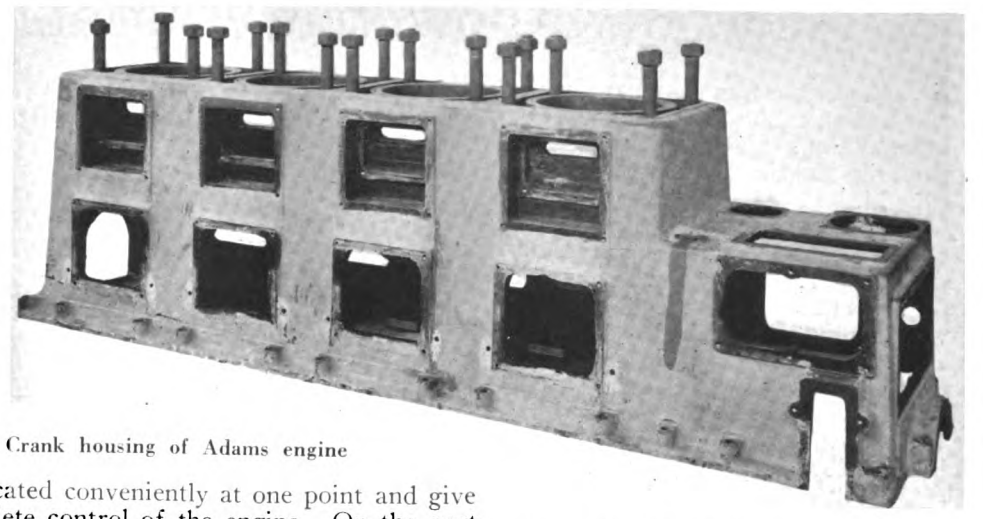
rings, all without breaking a pressure-joint. An advantage of the type of design is that pins and bearings may be run with a degree of clearance not permissible otherwise, an important consideration where engines are operated by men without great experience. Pins and bearings are unusually large and are constantly flooded with a supply of filtered-oil by a pump. The shaft, connecting-rods and cylinders are drilled for continuous force-feed lubrication. A mechanical oiler for the cylinder lubrication is mounted at the after end.

For direct reversing there is a set of cams which are moved into position and there is a set of cams for go-ahead position; the shift from one set of cams to the other is quickly made, reversing requiring only 8 to 10 seconds. In the illustration of the four-cylinder 150 h.p. Adams engine, which develops this power at 225 r.p.m. will be noted a clutch. This is supplied because in many harbors, notably on the Mexican coast, there are no wharves and the boat must get under way while anchored. There is a governor having a lever control for the tension of the governor-spring and this governor-contol, the reverse-lever and the starting-control lever are



Crank housing of Adams engine

all located conveniently at one point and give complete control of the engine. On the port side of the engine, at the aft end, are conveniently arranged on an extension of the lower base the fuel, circulating-water and bilge-pumps.

The 150 h.p. Adams Diesel-engine shown in the illustration is installed in the GRYME, a freight and passenger motorship owned by the Vancouver and San Diego Navigation Co., Ltd., of which George Beermaker, of San Diego, Cal., is president. The GRYME operates in trade between this country and ports on the West Coast of Mexico and is a link in American-Mexican business relations. Practically all of the supplies for these towns are purchased in this country and conveyed by motorships.

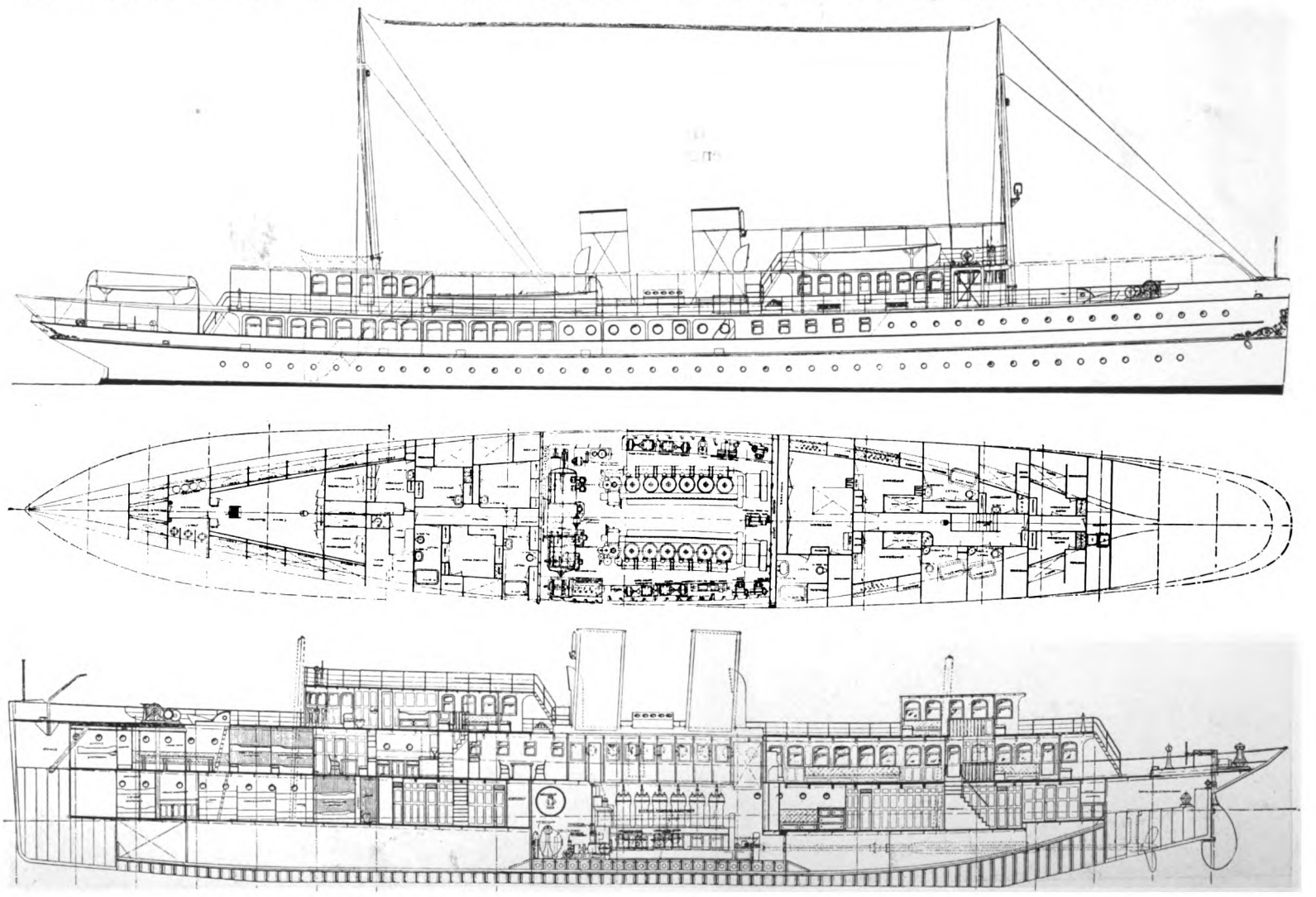
Alcedo, a New Deep-Sea Diesel Yacht

Twin-Screw 1,000 Shaft h.p. McIntosh & Seymour Diesel-Engined Vessel

DURING the world war, George W. Childs Drexel of Philadelphia loaned his beautiful steam yacht ALCEDO to the Navy Department for use in the war zone and she was unfortunately destroyed. Being a keen yachtsman, Mr. Drexel could not be without a large yacht in which to make deep-sea cruises, and it is pleasing to note that he has obtained designs from Thos. D. Bowes, of Philadelphia, for a large Diesel yacht of extremely pleasing appearance and arrangement.

This new craft will be of steel construction 214′ long, of liberal breadth and depth, and will be powered with two 500 h. p. McIntosh & Seymour four-cycle Diesel engines installed in a compartment amidships. The general arrangement plans of this new craft are shown herewith, through the courtesy of "Motor Boating."

In the engine-room will be noted a very complete installation of Diesel-electric driven auxiliaries, also a very complete and up-to-date equipment of deck auxiliaries. The ALCEDO will have a cruising radius of over 9,000 miles which will enable the owner to make cruises of several times the duration which a steam yacht of the same dimensions would allow. The lines of the boat as illustrated indicate a very fair turn of speed, and we believe that when this vessel is placed in commission a notable addition to the yachting fleet will have been made.



Plans of new oil-engined motor yacht "Alcedo," building for George W. Childs Drexel. She is 214′ long and will be propelled by twin McIntosh & Seymour Diesel engines

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New High-Powered Augsburg Diesel Engine

Merchant Marine Oil-Engine of 1,600 Shaft H.P., Built at the Augsburg Works of the M. A. N., Has Novel Features of Design—Designed to Run on Tar-Oil Fuel—Seven Hundred Hours Continuous Test-Run

BECAUSE an American firm, namely, the New London Ship & Engine Co., Groton, Conn., are licensees of the Maschinenfabrik Augsburg-Nüenberg, better known as the M. A. N., and because manufacture may be started in this country, a new design of merchant-marine oil-engine recently completed at their Augsburg plant will have nearly as much interest in this country as in Germany, especially as it embodies the very latest ideas of German engineers resulting from war and post-war experiences. The Augsburg Works have always adhered to the four-cycle Diesel while the Nürnberg factory has steadily developed the two-cycle system, and the big Diesels of the U. S. Navy tanker MAUMEE were built at the New York navy yard to Nürnberg design about five years ago.

Before the War the M. A. N. had taken up the design and construction of slow-running Diesel engines for commercial marine purposes, partly in their own works and also in connection with their licensees. The War itself brought to an involuntary halt the development of these engines, as during the War the construction of fast-running Diesel engines for submarines was taken up, and the extraordinary activity and remarkable production of the Augsburg Works of this Company towards this end are very well known, and their 3,000 b.h.p. engine was exclusively described in our issue of January, 1920.

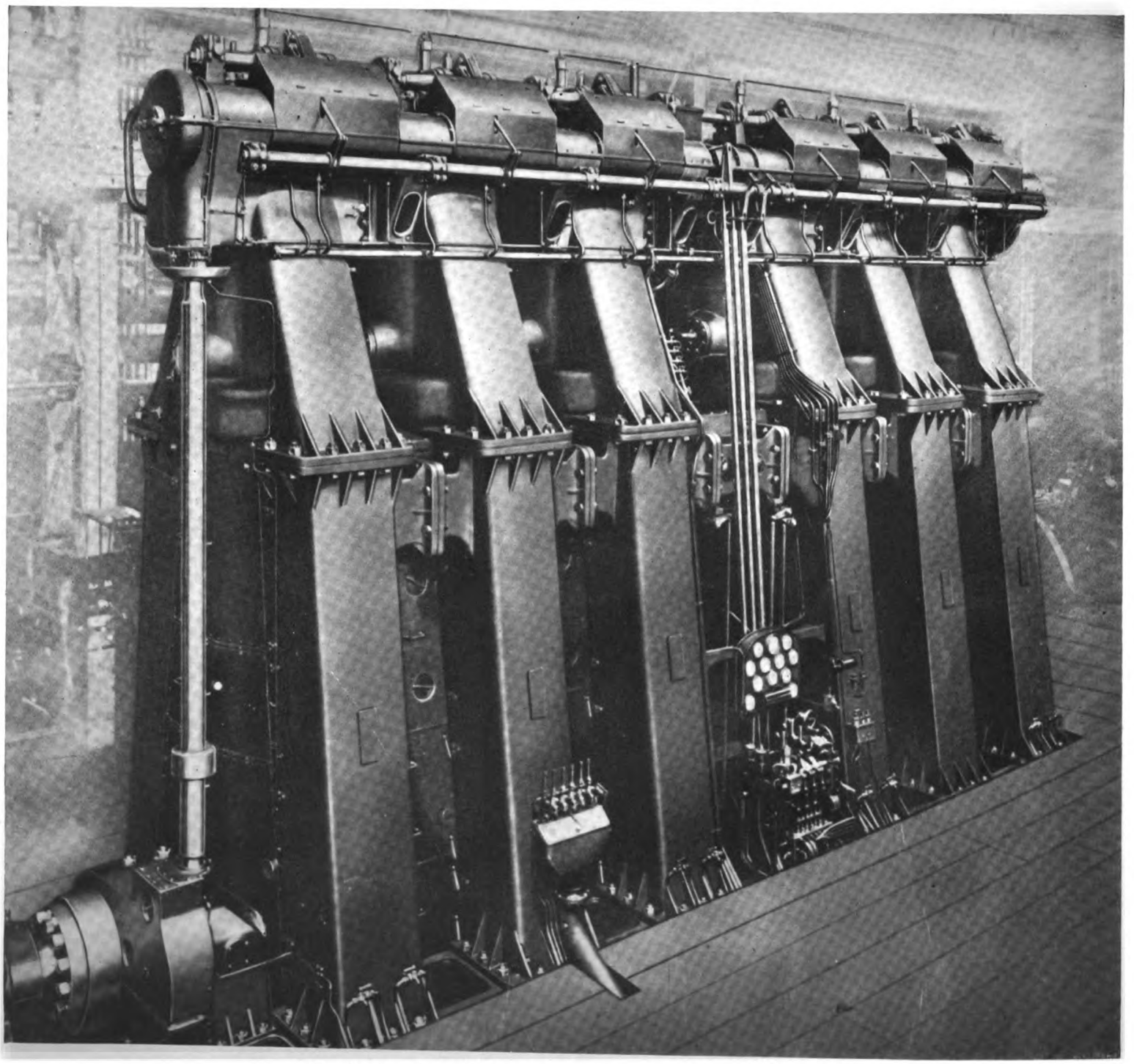
At the end of the War, M. A. N. again turned to the development of the slow-running marine engine, and of course were able to apply all the experience gained during the construction and subsequent running of the many submarine engines built. When designing the engine herein described, the M. A. N., working in connection with Blohm & Voss, Hamburg, the Vulcan Works, Hamburg, and also the A. G. Weser Works, Bremen, took into consideration the various approved practices of steam-engine construction in connection with the dimensions and appearances of the working parts, so that when the engine was finally built and tested at Augsburg it was found that the ideals aimed at were realized, and that practically no changes of any kind were found to be necessary.

This engine, which we illustrate, is designed for a 9,000-ton, twin-screw motorship now being built at the Weser plant. Its rating is 1,600 shaft h.p. at 100 r.p.m., and the dimensions of the six cylinders are:

Diameter—27 9/16"
Stroke—47¼"

which at rated power and revolutions gives a mean-effective pressure of about 74 lbs. per square inch. To comply with the requirements of the owners the engine was designed to utilize tar-oil, which is a by-product of hard coal.

Due to a delay in the construction of the ship for which the engine is intended, the opportunity was afforded to undertake some conclusive and extended tests of the engine on the test-bed at Augsburg. Very complete in-



The Augsburg 1,600 shaft h.p. four-cycle type Diesel marine engine

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formation was obtained, and the engine was run continuously for 700 hours. The total running time was 1,150 hours, and the 700-hr. continuous run consisted of:

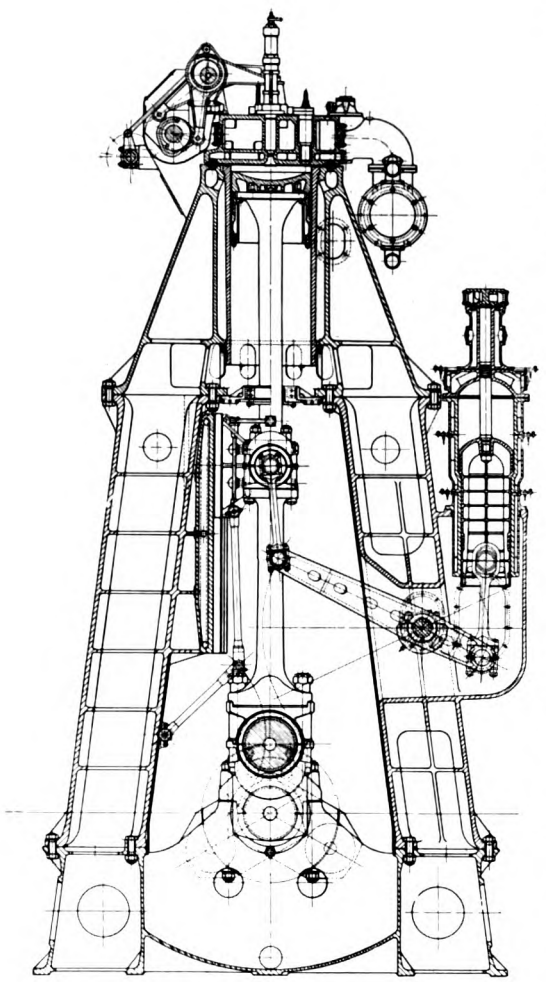
310 hours at full-load with cold cooling-water,—Inlet 41° F.—Outlet 113° F.
210 hours at full-load with warm cooling-water,— Inlet 86° F.—Outlet 118° F.
163 hours at varying loads,—5 hours at 220 b.h.p., 50 r.p.m.—(Minimum speed)
10 hours at 2,000 brake h. p. 122 r.p.m. highest load.

During this time the engine ran 150 hours with tar-oil, 27 hours with Bunker C fuel-oil, 622 hours with tar-oil in three cylinders and Bunker C fuel-oil in three cylinders. During this latter test seven short reversing maneuvers were made. The specifications of the tar-oil used correspond to those used for tar-oil as burnt in stationary Diesel engines in Germany and Austria. The bunker fuel-oil was delivered by the German-American Petroleum Corporation, Hamburg, and was a residue of Mexican crude. The specifications of both oils are given in the table:

	Tar-Oil.	*Bunker-Oil.*
Appearance	Thin flowing	Very thick flowing
Color	Black green	Black
Specific gravity at 60°F	1.075	0.970
Water content	0.2%	0.2%
Cold test	at +59°F. (No separation)	.....
Pour test	at — 14°F. still flows	at +50°F. solid
Viscosity (Saybolt)	68°F. —70. Sec.	104°F. —3,000. Sec.
	122°F. —37. "	140°F. — 900. "
		176°F. — 514. "
		212°F. — 274. "
Flash-point in open cup	185°F.	118°F.
Coke content	1%	10.6%
Incombustible substances (ash)	0.012%	0.04 —0.1%
Indissoluble substances in Benzin or Xylol	0.028%	0.76%
Carbon	89.0%	84.1%
Hydrogen	6.7%	10.8%
Sulphur	0.6%	3.6%
Heat value, B. T. U.	16,100	17,300
Boiling analysis beginning at	410°F.	446°F.
Amount distilled at	419°F. = 1%	464°F. = 1%
(Carbon Residue Test)	437°F. = 8%	482°F. = 4%
	482°F. =26%	527°F. = 8%
	527°F. =42%	572°F. =14%
	572°F. =56%	617°F. =18%
	617°F. =70%	662°F. =26%
	662°F. =82%	Residue =22%
Color of the distillates	Yellow later red brown	Green yellow, then brown yellow
Residue	Pitch soft	Pitch mass

As will be seen by the various illustrations the engine is different in appearance from the average marine oil-engine, and is of exceptionally clean-cut design. The bedplate, of grey iron, consists of two parts bolted together in the center, and is provided with eight cross girders for the main bearings. It is entirely closed on the underside—forming an oil pan. The separate crank bays are connected to each other by openings of proper cross section. At both ends of the bedplate openings are fitted for draining off the lubricating oil.

The crankshaft is designed in accordance



Cross section of Augsburg 1,600 b.h.p. oil-engine

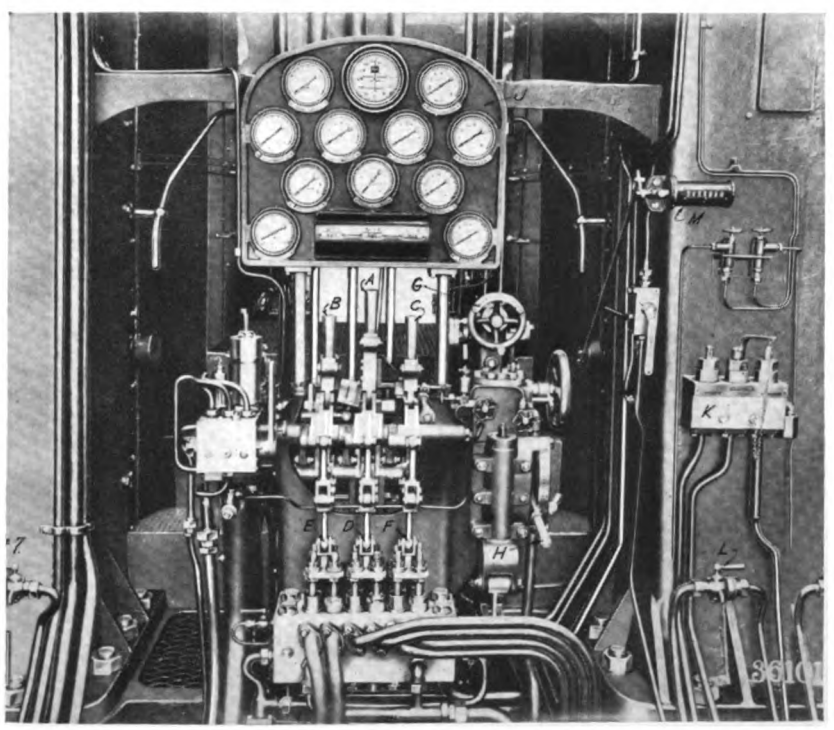
with German Lloyds' requirements, the diameter of the crankpins and shaft journals being 17⅛". It is in two sections bolted together, and each section has three throws set at 120° apart, the whole shaft being supported by eight main bearings of ample size. The shells are of steel lined with white metal. Following present-day practice the lower halves are cylindrical, and thus can be turned out for examination and refit without removing the shaft. In order that the bearing clearances may be determined conveniently at any time the upper halves are provided with openings. Lubricating-oil supply to these bearings comes up through the lower halves, and in this connection a three-way cock is provided on the piping to each bearing, which when opened enables the temperature of the oil or of the bearing to be ascertained easily.

Cast-iron A-frames of box section are located on the bedplate, bolted together at their upper ends by means of special brackets. This insures a stiff and rigid construction, which is confirmed by the vibrograph tests made on this engine, and which are referred to later. The A-frames are provided with brackets for holding the cross head guides, of which the ahead guides are of cast-iron and water cooled, while the astern guide strips are of steel and adjustable. The two center A-frames on the outboard side support the air-compressors and their actuating levers.

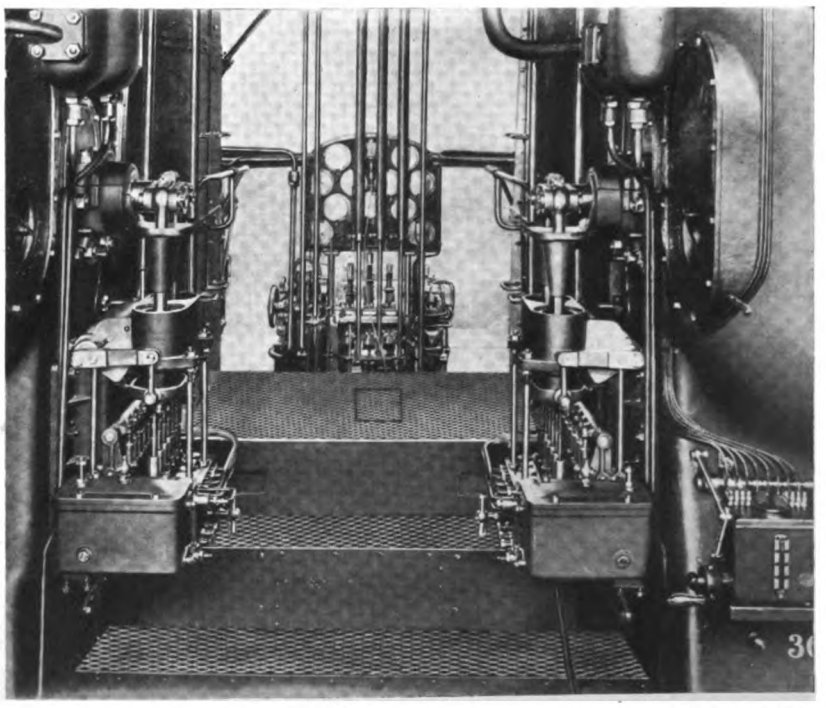
Cast-iron cylinder liners are fitted into the separate cylinders, the liners being packed at their lower ends by means of rubber rings. Large holes accessibly placed provide for the cleaning of the water-cooling spaces. The lubricating oil for pistons is supplied by a forced-feed pump to four holes in the lower uncooled and projecting part of each liner. The working cylinders are entirely separate from the crankshaft space by means of a division plate and stuffing-box. This prevents a mixture of the piston lubricating and bearing lubricating oil. Means are provided for recovering the piston lubricating oil, which after purifying is used again.

For the working piston, cast-steel has been adopted and the inner side is provided with a number of circular ribs which bear against the flange of the piston-rod, thus transmitting the combustion-pressure directly to the piston-rod, and is so fitted that radial expansion is provided for. It is secured to the piston-rod by means of a bushing bolted to the piston-skirt and which bears against the under surface of the piston-rod flange. We are enabled to give a drawing showing this construction.

Oil is used for the cooling medium of the pistons which is unusual with engines of this low speed and high power, the general practice being salt or fresh water. Because of the design of the ribs the oil passes through the piston-head generally in a circular direction at very high velocity, and consequently produces an exceedingly good heat transfer. The oil is led to and from the piston through the hollow piston-rod and by elbow pipes which are secured to the A-frames, and also the cross head slipper. Discharge pipes from each piston are carried separately to a funnel so that each individual oil discharge is visible, and therefore can be continually under observation both with regard to quantity and temperature.



Fuel pumps and gauge board on the Augsburg engine



Control platform between the two engines showing fuel pumps. On the right is one of the mechanical lubricators

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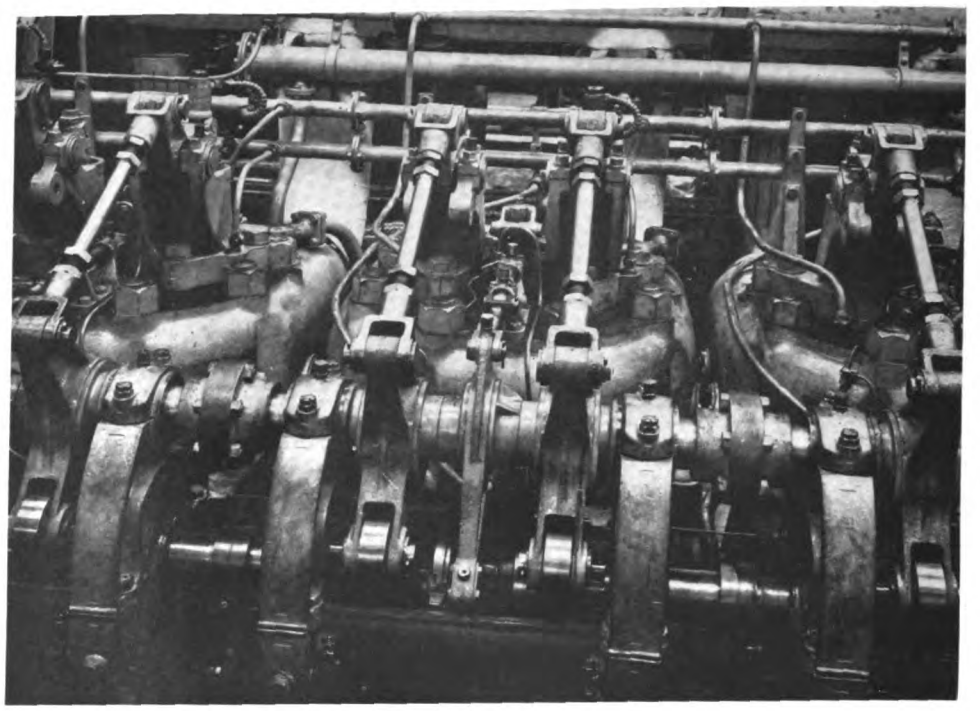
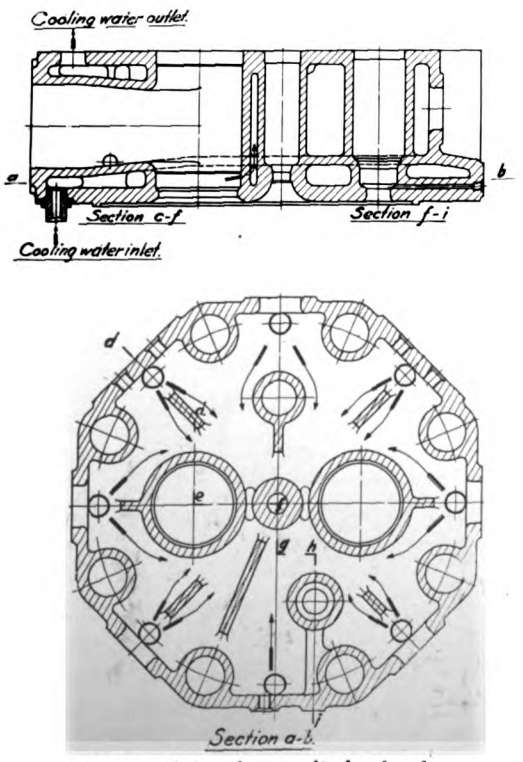
Regarding the connecting-rod, crankpin and cross-head bearings, compression adjustment is obtained by inserting shims between the connecting-rod and crankpin bearing box. Cross-heads and cross-head slippers are lubricated by oil supplied through the hollow connecting-rod.

Another point of special interest is the construction of the cylinder cover, also illustrated by a drawing. The cooling-water space is divided into two unequal parts by a horizontal wall so arranged that the cooling-water which enters the lower compartment from the cylinder jacket through eight connections on its circumference is led toward the center with gradually increasing velocity, from whence it passes upward into the upper compartment, which is about four times the volume of the lower compartment, which causes a reduction in velocity and is then discharged from the top of the head. By means of this construction very good cooling of the hottest part of the cylinder-head is effected, and excessive heating with accompanying harmful heat stresses and possible eventual cracks should be avoided The cooling spaces are provided with ample sized core and hand holes easily accessible so that originally the coarse sand and core-irons can be entirely removed. Subsequently cleaning is easily effected in service.

Being a four-cycle engine, the cylinder-head contains starting, inlet, exhaust, fuel and safety valves. Each valve can be removed independently of the others and without the necessity of disassembling the rocker-arm shaft. Water cooling of the exhaust-valve cage is arranged, but the stem of the valve is of special material and is uncooled. The fuel-valve is designed to operate on tar-oil, and is also fitted with a simple device for varying the stroke of the needle valve. By reducing the lift at lower powers and fewer revolutions combustion takes place more slowly and quietly and with a lesser maximum pressure than when the full lift is used for low powers as will be seen from the indicator diagrams. In addition, very much less injection-air is needed than is ordinarily the case. All valves are operated in the usual manner by means of cams and rocker-arms. The camshaft has a double set of cams, and is arranged to shift in a fore-and-aft direction for altering the direction of rotation of the engine. To facilitate the removal of the spray valve the fuel-injection valve rocker-arm is constructed in two parts;



View of valve operating mechanism



Design of Augsburg cylinder head

it is also so designed that the time of opening as well as the amount can be adjusted while the engine is running. By loosening the nut A, marked on the photographic reproduction of the rocker, the clearance between the roller and the cam in a radial direction can be varied by about plus or minus 0.06". After loosening the nut B by turning the bolt C, the cam-roller can be moved in relation to the cam about 0.15" in a tangential direction. Because of these features the engine is easily tuned-up in service whenever indicator cards show this to be necessary.

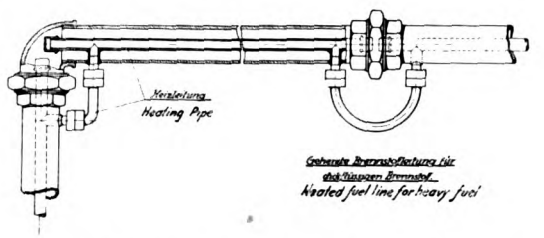
Each working cylinder has its own main fuel-pump and ignition-oil pump. These two groups of fuel-pumps have forged steel bodies, and are driven by the shafts forming the pivoting element of the two air-compressor levers as shown. The pump plungers are of hardened steel and are fitted with cast-iron bushings, no additional packing being necessary. By lifting the suction-valve in the ordinary manner by means of the hand-wheel G on the operating platform the amount of fuel delivered is controlled. There is a separate illustration of this.

The fuel-pump is so connected with the starting gear that no fuel is supplied when turning over under air, and in addition the governor acts directly on the pump suction-valves when the normal revolutions of the engine are exceeded by about 6 to 8%.

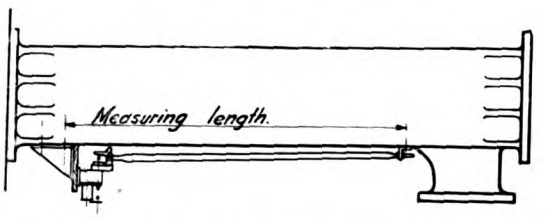
There are two 3-stage independent compressors situated at the back of the engine, so as to make the total engine length as short as possible. They are driven by levers from Nos. 3 and 4 cross-heads. An air-cooler, water and oil separators are provided for each stage, whilst lubrication is provided for by means of independent mechanical oilers.

The operating platform is located between cylinders 3 and 4 where all the necessary levers for operating the engine are located. Referring to the illustration of the operator's platform, levers A and B serve for starting the engine. Lever C for maneuvering. These levers actuate the small levers D, E and F, which control the oil pressure for the servo-motor. The servo-motor operates with pressure oil taken from the forced lubrication system of the engine, which pressure is raised to about 220 lbs. per square inch by means of compressed air. Arrangements are so made for starting and also for maneuvering that these operations can be accomplished entirely by hand.

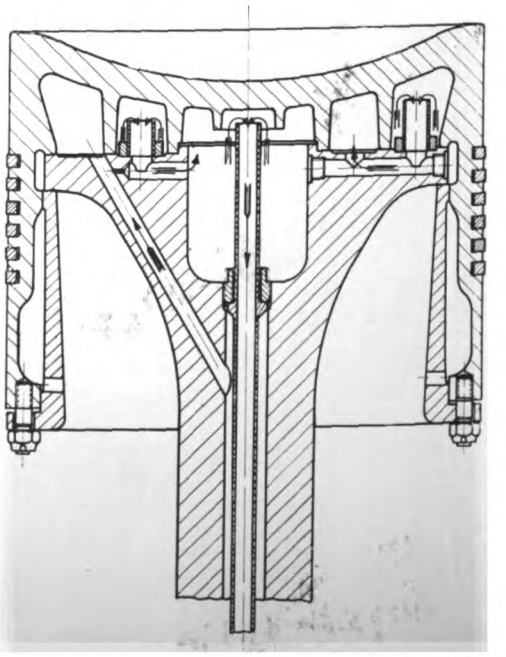
Maneuvering of the engine is accomplished by shifting the camshaft fore and aft. For starting, all six cylinders are operated on air; by shifting the lever A from the starting to the running position three cylinders are thrown on fuel, while the other three still operate with air. As soon as the first three cylinders fire,



Method of heating fuel-feed line when using heavy oil



Arrangement for measuring the variation in length of the sixth frame of the engine



Section of Augsburg piston showing method of cooling by oil

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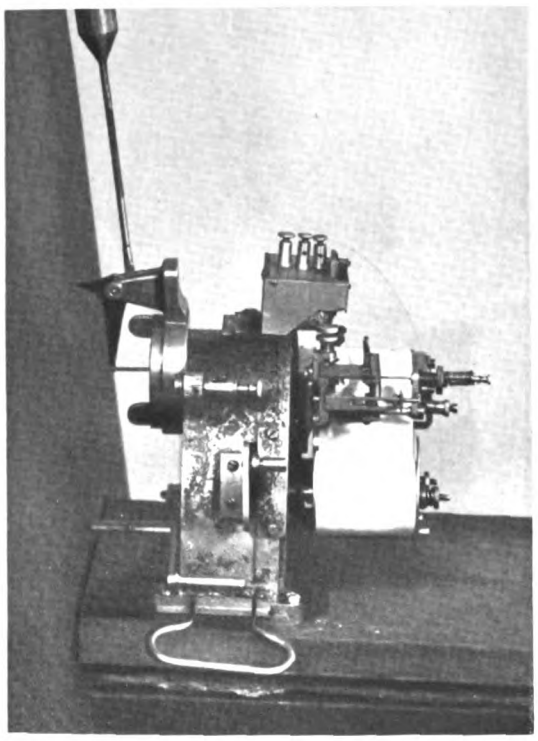
then the lever B is thrown to the running position and the other three cylinders are placed on fuel. The levers A, B and C are so interlocked that incorrect movements are impossible. The starting-air before entering the cylinder passes through a reducing-valve which is set at about 220 lbs. per square inch.

The hand-wheel G located on the operating platform is used for regulating the fuel-pump, and the lever H regulates the air-compressor throttle valves. On the A-frame of the engine an overflow valve K is fitted which permits the excess air of the main compressors to be delivered to the air bottles; there also being fitted a cross connection between the compressed-air piping of both engines. The gaugeboard J contains all the necessary instruments for showing the direction of rotation, the maneuvering position, and also the tachometer. A revolution counter M is also conveniently fitted.

Hand-wheels for adjusting the oil pressure for the bearing lubrication and piston cooling as well as the automatic injection air-pressure regulator are not visible in the illustration.

For oil circulation, two electrically-driven pumps are provided which take the oil from



The Torsiograph used for measuring stresses on the Augsburg engine frames

the main oil-tank and pump it through two connected filters and the oil-cooler to the engine. A larger proportion of the oil is used as the cooling medium for the working pistons, while the smaller proportion is cooled to a lower temperature and is supplied to the bearings for lubricating purposes. The main and compressor cylinders are lubricated by specially driven mechanical lubricators. The oil draining from the cylinder skirts is caught, filtered and re-used. Sea water is used for the cylinder jackets and also for the oil coolers, and is provided by means of two electrically-driven centrifugal pumps. All pumps are of such size that one alone can supply both main engines.

As already described the engine is designed for the use of tar-oil in conjunction with ignition-oil. This procedure which the M.A.N. has used on all of its stationary tar-oil engines consists of one of the main fuel-pumps supplying a small quantity of ordinary Diesel fuel into the lowest part of the nozzle. When the needle opens, the quantity of ignition-oil is injected into the cylinder first and immediately ignites and consequently the less volatile fuel

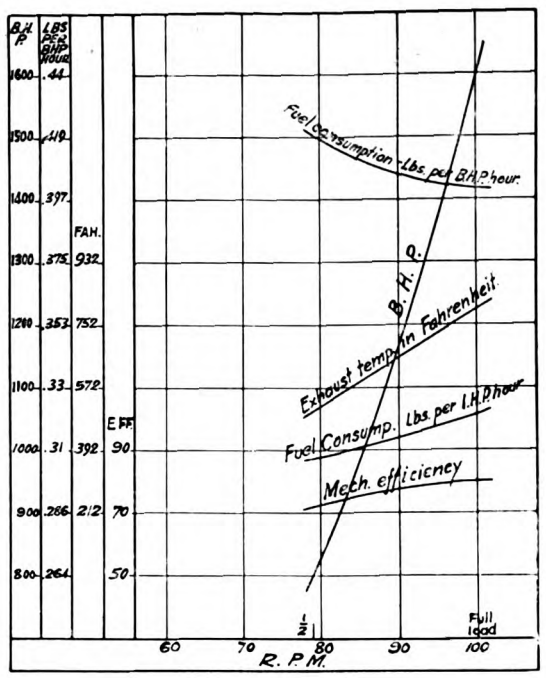
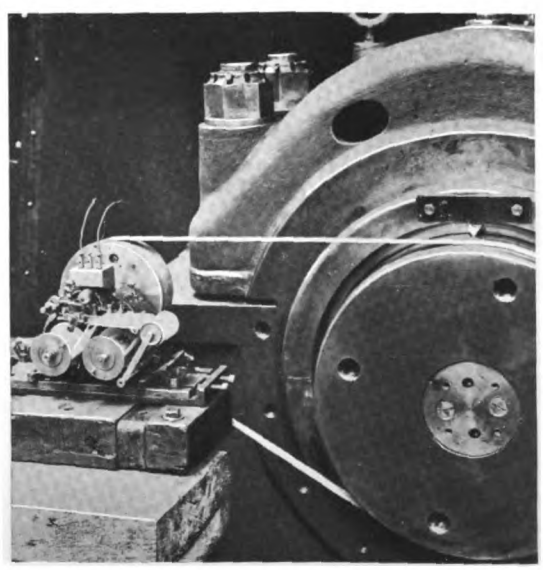


Chart of test of Augsburg engine

which follows is ignited by it and burns completely. As gas-oil (solar-oil) oil distilled from Lignite, Shale, Diesel-oil, etc., can be used as ignition oil, the total consumption is not higher than when running with only one kind of fuel having regard to the calorific value of the fuels themselves. (A very complete article on the uses of tar-oil with Diesel engines is given in the MOTORSHIP YEAR BOOK of 1922, price $2.00).

The engine ran with tar-oil and ignition-oil at all loads with absolutely clear exhaust. The starting and maneuvering was accomplished quickly and without it being necessary to switch the fuel-pumps entirely on ignition-oil The appearance of the cylinders, pistons, exhaust-valves, etc., at the end of the continuous run was entirely satisfactory. Consequently tar-oil can be used under the proper conditions as fuel for marine Diesel engines. It is found, however, that an actual mixing of tar-oil with Diesel-oil, crude-oil or lubricating-oil produces asphalt deposits, which by clogging up the pipes, valves, etc., can cause troublesome operating conditions. The mixing of both kinds of oil should be absolutely avoided and therefore the arrangement and design of the supply tanks in the ship should take cognizance of this fact.

The use of the boiler-oil in the other three cylinders was rendered considerably easier by using ignition oil. The experiences of the M.A.N. in stationary practice was of great assistance in solving the problem of using vis-



Instrument for registering crankshaft vibrations

cous boiler fuel. Due to the high proportion of real residue in this oil a slightly higher compression than normal is necessary for complet combustion. These combustion requirements, especially in a cold engine or at light loads, are frequently such that lead to missing and late ignition with a poor exhaust. When using ignition-oil the best of operating conditions with regard to ignition and combuston are obtained at all loads and revolutions. After the continuous test the pistons and cylinders showed no wear. Furthermore, the exhaust-valves and seats were in good condition. The ignition-oil arrangement renders the use of the viscous oil permissible under all conditions of operation.

The arrangement for the heating of the oil from the tanks to the fuel-pump and the intervening piping is of interest. Figure 8 shows the patented construction used by the M.A.N. whereby the heating pipe is contained inside the oil pipe; all pipe connections are external so that leakage of water into the oil is avoided, and the oil is heated along the en-

Fuel-valve rocker showing adjustment device

tire length of pipe so that accumulations of cold thick oil in bends, etc., are avoided. The heat loss with an internal heating pipe is much smaller than that when the pipe is exposed to the atmosphere. The fuel-pump and the pump discharge pipes to injection-valves are also heated. Another point which must be watched when using this viscous oil is the very high content of ash (incombustible substances in the oil). This will cause undue wearing of the cylinder liners if it exceeds 0.05%. The bunker fuel-oil used on these trials contained an ash content of 0.04 to 0.1%. By filtering in a suitably heated filter this quantity was reduced to 0.04 to 0.06% and it was found that by this means, combined with a proper arrangement for cylinder lubrication, it was possible to restrict the wear of the liners to reasonable limits. The following table shows the test figures when operating with tar-oil and bunker fuel-oil at normal load:

TABLE

	Tar-Oil & Ignition-Oil	*Bunker-Oil & Ignition-Oil*
R. P. M.	100.04	100.01
B. H. P.	1630	1647
Mean indicated pressure (lbs. per sq. in.)	96.5	98.5
Indicated H. P.	2030	2064
Mechanical efficiency (%)	80.3	80.0
Fuel consumption (lbs./hr.)	712	603
Ignition-oil consumption (lbs./hr.)	37.6	38.4
Total fuel consumption per i.h.p. hr. (lbs.)	0.368	0.310
Temper. of fuel before injection valve (°F)	64	167
Injection pressure (lbs. per sq. in.)	1090	1180
Cooling-water temper. before entering cyls. (°F)	41	41
Cooling-water temper. after thru cyls. (°F)	125	113
Piston cooling-oil before entering (°F)	86	86
Piston cooling-oil after thru piston (°F)	106	108
Bearing lubricating-oil before entering (°F)	77	77

One of the diagrams shows the relation between fuel-consumption, mechanical-efficiency, power and exhaust temperatures at various

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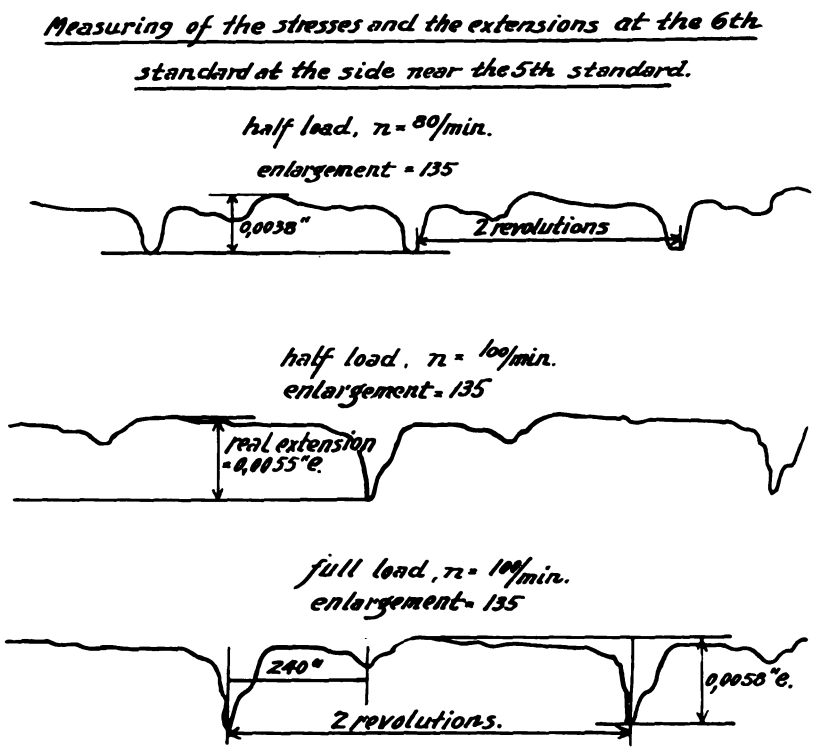
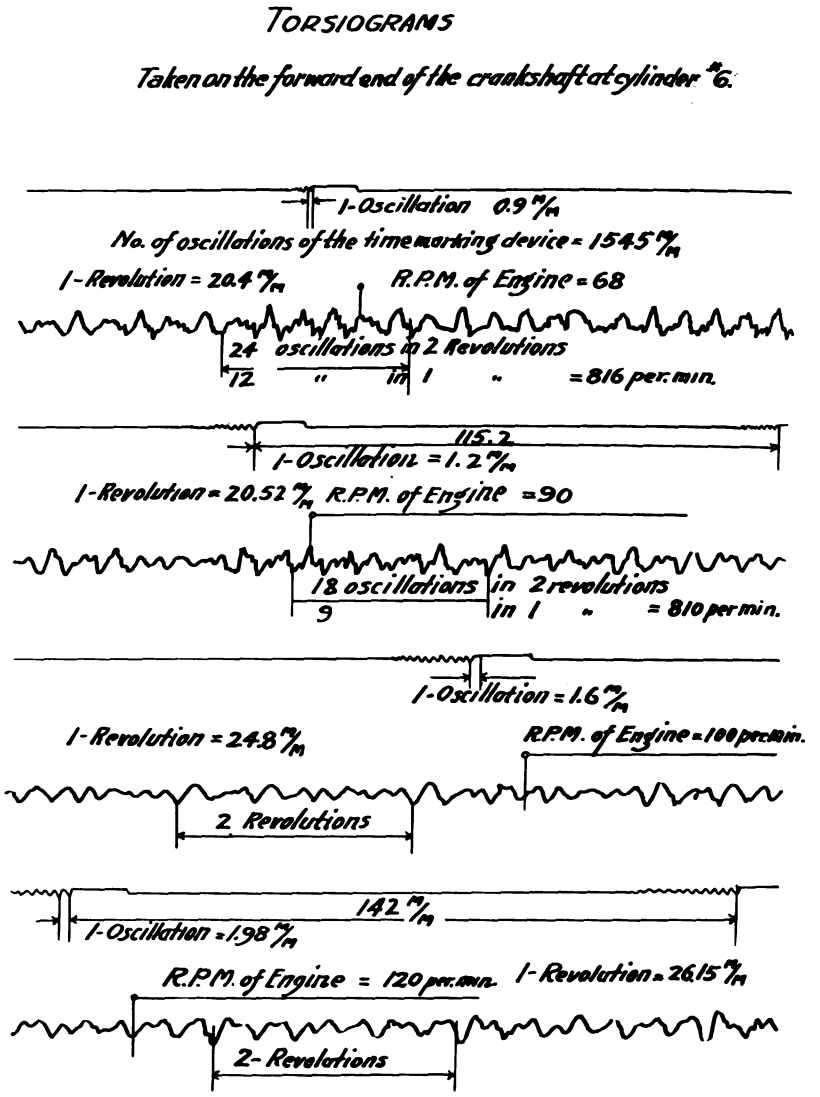

Measuring of the stresses and the extensions at the 6th standard at the side near the 5th standard.
half load, n = 80/min.
enlargement = 135
0,0038"
2 revolutions
half load, n = 100/min.
enlargement = 135
real extension = 0,0055"e.
full load, n = 100/min.
enlargement = 135
240°
0,0058"e.
2 revolutions.


TORSIOGRAMS
Taken on the forward end of the crankshaft at cylinder "6.
1-Oscillation 0.9"/m
No. of oscillations of the time marking device = 1545"/m
1-Revolution = 20.4"/m
R.P.M. of Engine = 68
24 oscillations in 2 Revolutions
12 " in 1 " = 816 per min.
115.2
1-Oscillation = 1.2"/m
1-Revolution = 20.52"/m
R.P.M. of Engine = 90
18 oscillations in 2 revolutions
9 in 1 " = 810 per min.
1-Oscillation = 1.6"/m
1-Revolution = 24.8"/m
R.P.M. of Engine = 100 per min.
2 Revolutions
142"/m
1-Oscillation = 1.98"/m
R.P.M. of Engine = 120 per min.
1-Revolution = 26.15"/m
2-Revolutions

revolutions of the engines in the ship. Another diagram illustrates the indicator card when running with tar-oil and with bunker fuel-oil; the diagrams for minimum power (220 b.h.p., 50 r.p.m.) were made by adjusting the needle stroke, which effect is noticeable in lowering the maximum combustion pressure. The lowest r.p.m. of the engine, which is determined by the turning moment of the rotating masses, was 28.

The lubricating-oil consumption of the engine during the test run was found to be 4.8 gallons per engine hour, when no oil is recovered. If the oil is purified through a proper filtering device and again used, the consumption is about 1.1 gallons per engine hour.

Of special interest are the tests which were carried out on the crankshafts, camshaft and the engine itself for the purpose of determining vibrational oscillations. The M.A.N. has long given much attention to these oscillations, which, as is well known, are of great importance for marine engines, and has accumulated a vast amount of data on this subject during the construction of fast running Diesels. The data today exercise considerable influence over the various conditions governing the design of an engine. The experimental tests, which are carried out on each new type of engine, serve not only to confirm calculations, but also assist very materially in extending knowledge of this subject which is again embodied in new designs.

The determination of the oscillations of the shaft under the necessarily varying turning moment applied, modified by the position and extent of rotating parts of the engine, was carried out by means of a Torsiograph developed by Dr. Geiger, one of the M.A.N. staff. This instrument is especially designed for tests of this kind and can be easily applied to all parts of the engine. It records the angular deviations of a rotating shaft in relation to a mass revolving at a uniform speed. The timing of the oscillations in relation to revolutions, speed of paper, etc., is arranged for by marks made on the paper by means of what is practically the tuning-fork method; also the dead centers of any piston can be recorded. Torsiograms accompanying this article were taken on the forward end of the crankshaft at varying revolutions per minute. Due to the weight distribution of the installation, weak critical speeds of 12th and 9th order were observed at 68 r.p.m. and at 90 r.p.m., respectively, while the operating speed of 100 r.p.m. was entirely free from oscillations. By means of the torsiograms, the most suitable speeds can be determined.

For ascertaining the vibrations of the engine itself, the Vibrograph, also designed by Dr. Geiger, was used. This instrument, which operates on a principle similar to that of the Seismograph, serves for recording oscillations in a horizontal or vertical direction. The Vibrograms taken on the engine show that, within the operating speeds, only very minute vertical and horizontal movements are noticeable, and these are negligible. Only at a speed of 120 r.p.m., which lies substantially above the highest speed of the engine, could resonant oscillations of the A-frame and cylinder combined, taken at right angles to the crankshaft and in a horizontal direction, be observed.

Stresses of the A-frames themselves were ascertained with the help of the Vibrograms, which show, very much magnified, the variations of length between two points. The diagrams show the arrangement for measuring the variations in length of the 6th frame. The instrument was attached to the bottom part of the A-frame and a rod was connected to the upper part of the column and to the recording lever on the instrument. A variation in length of 1/500" can be recorded. Diagrams taken on the 6th column are shown.

It is obvious that the column increases its length during the compression stroke and reaches its maximum at the moment of ignition. Also the effect of the firing in the adjacent cylinder, which has an angular separation of 240°, is evident in the Vibrogram. It follows, therefore, that the A-frames distribute the loads by transferring them to adjacent columns through their upper connecting brackets, which was their designed function. The highest tensile stress of the columns, according to the diagrams, amounted to about 720 lbs. per square inch.

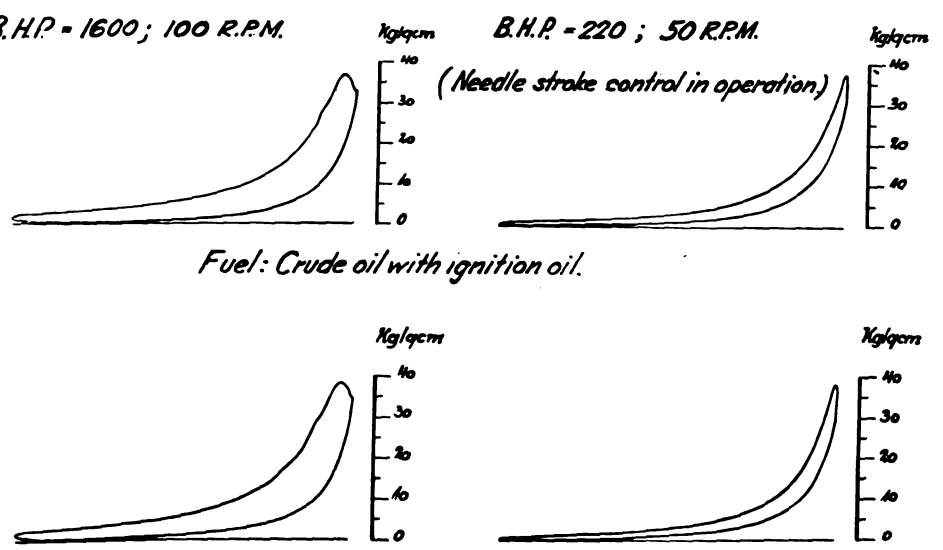


Figure "10

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First Diesel-Electric Propelled Warship

"Pelikaan," a 2,400 Ton Submarine Mother-Ship of the Royal Dutch Navy, Runs Successful Trials. Starts on Voyage to Other Side of the World

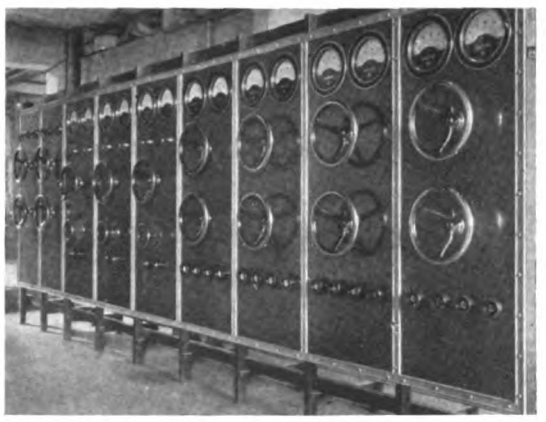
BECAUSE of the limited funds available to them one does not usually look to the lesser navies for radical developments in war vessels and their systems of propulsion, particularly in the more conservative countries. But it is due to the enterprise of the Royal Dutch Navy that the first Diesel-electric propelled war-vessel is now afloat. This is the PELIKAAN, a submarine mother-ship of 2,400 tons displacement, which represents a marked step in the application of electric transmission in connection with oil-engines and ship propulsion. We believe we are enabled to give our readers the first illustration of this most interesting craft.

The PELIKAAN has just been completed at the Netherland Shipbuilding Yard, (Nederlandsche Scheepsbouwmaatschappij) Amsterdam, Holland, and was delivered to the Holland Government on September 1st. She has started on her long voyage to the Far East, where she will be stationed to "mother" the submarines in service in those waters. This extended trip will afford every opportunity for a thorough test of both the Diesel and electrical machinery.

Her dimensions are as follows:—

Length O.A.	309¼ ft.
Breadth	36¾ ft.
Depth	26 1/3 ft.
Draught (mean)	13 1/6 ft.
Displacement	2,400 tons
Power of Diesels	1,400 b.h.p.
Power of motors	1,140 s.h.p.
Speed of ship	12 knots

For propulsion purposes there are two Diesel engines of 700 brake h. p. at 250 r. p. m. coupled to 390 volt D. C. generators, which supply current for two 570 shaft h. p. electric motors turning at 190 r. p. m. The Diesel engines are of the Nürnberg 6-cylinder, 2-cycle, trunk-piston type with air injection. They were built at the Nürnberg Works of the Maschinenfabrik Augsburg-Nürnberg, Germany, and are of the valve-in-head scavenging type, the scavenging pressure being maintained by piston pumps. The working-pistons of the engines are cooled by oil. The mean indicated pressure of the engines is 100 pounds per square inch, which is higher than usually found in two-cycle engines.



Control-board in the engine-room of the "Pelikaan"

It is rather curious that the Dutch Government should have gone out of the country to purchase Diesel engines when there are several important experienced Diesel-engine builders in their own country. Possibly the very favorable rate of exchange made considerable difference in the cost.

In addition to supplying current for the twin propelling motors the generators furnish current for charging the storage batteries of submarines and for various auxiliary purposes on the ship herself. On the shaft of each dynamo a second generator is mounted, which supplies current at 22 volts and 360 amperes maximum, serving for exciting the generator field. By regulating this current the voltage of the current for the motors is varied for the purpose of controlling the ship's speed.

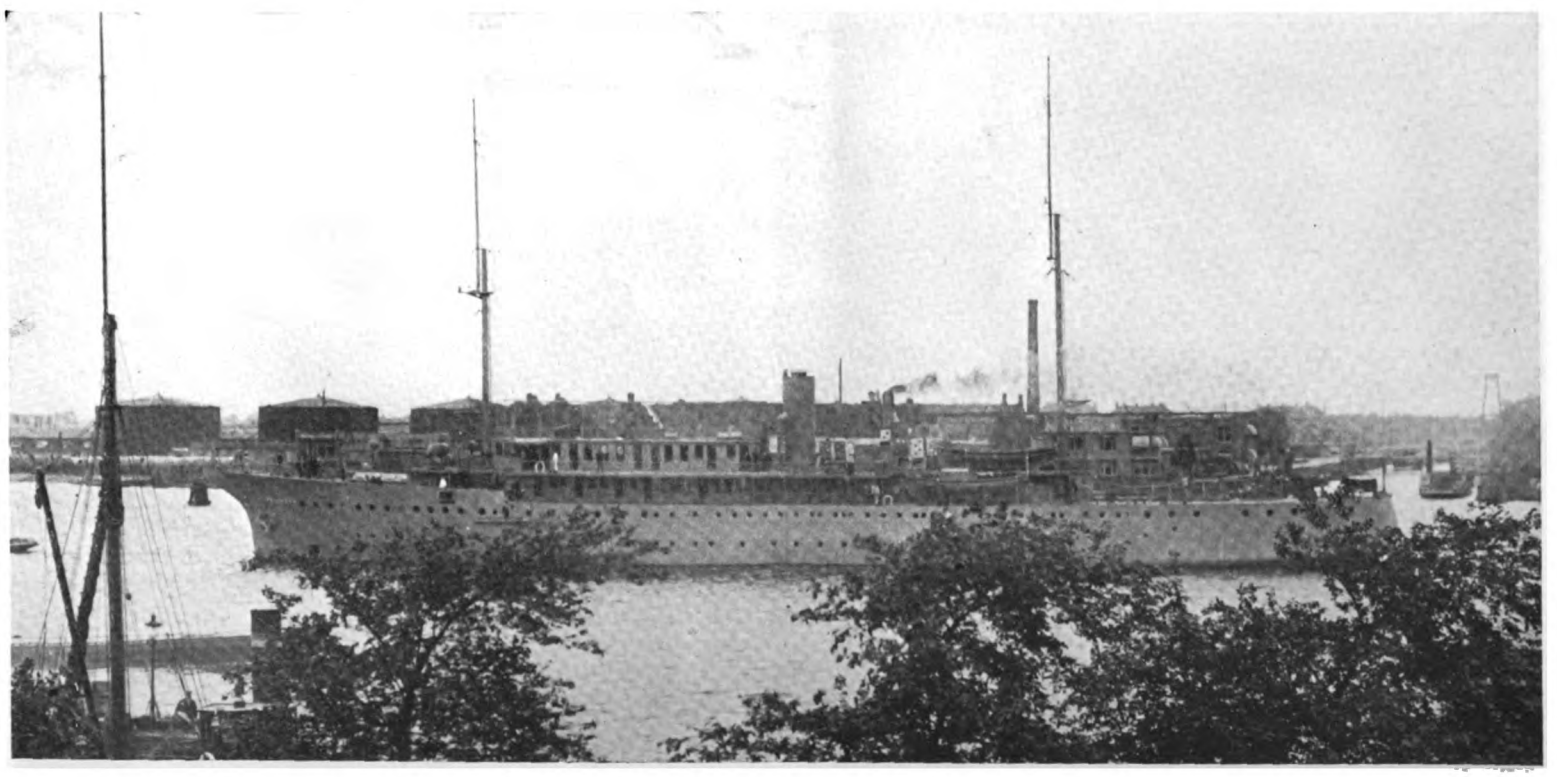
The propelling motors are coupled direct to the shafts, and each is rated at 570 b. h. p. at 190 r. p. m. The propeller shafts are provided with horse-shoe type thrust-bearings. Each motor can be driven separately or together from either of the Diesel-electric generating sets. Electricity plays a very important part in connection with the equipment of the entire ship; consequently the electrical plant is very complete. There are two smaller Diesel engines built by the Atlas Diesels Motorer, Stockholm, Sweden, which are used for providing power for generating current when the vessel is in port. Each of these engines has three cylinders, works on the four-cycle principle and turns at 550 r. p. m.

A third electric system is furnished by the installation of a converter for securing direct current at 220 volts from a shore supply. This converter is arranged that it can work with current of varying voltages, namely from 77 to 456 volts, making it possible to take the current from the shore supply in almost any harbor.

We have just stated that the electrical equipment is very complete so it may be mentioned that altogether there are about 60 electrical auxiliary motors connected to the power circuit of the ship and in addition electricity is supplied to the water heaters, stoves, storage battery, and Marconi wireless set.

In addition to the usual ship's auxiliaries in the engine-room and on deck there are series of motors for naval purposes, such as compressing air for torpedo, munition, boat and airplane hoists, and for a series of machine tools for torpedo and general repair work. For steering the vessel there is a Hele-Shaw-Martineau hydro-electric steering-gear with a MacTaggart-Scott control. This equipment has been provided with a special electric safeguarding system designed by Groenevelt Van der Poll & Co., Ltd., of Amsterdam, which company installed the electric equipment. The principal electric motors and generators were built by the Electro-technical Works (Electrotechnische Industrie).

The main control board is mounted on the engine-room flat where there is ample space for its operation. Up to the present time no arrangement has been made to control the propelling motors from the bridge. Several trial trips have been run with success and the vessel obtained a speed of 12 knots.



The Dutch Diesel-electric propelled warship "Pelikaan"

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"MOTORSHIP'S" NEW ADDRESS

Will all our readers kindly take note that the business and editorial offices of MOTORSHIP have been moved to 27 Pearl Street, New York, just off Whitehall Street, right in the heart of the shipping district. From now onwards all correspondence should be sent to the new address.

THE MARINE SURFACE-IGNITION OIL ENGINE

IT is not generally known that the modern marine type of surface-ignition engine that is so popular among all classes of work-boats outdates the Diesel engine, the original Akroyd patents being granted in 1890 when the first two engines were built at the Bletchley Ironworks, England. The design was taken up by the Richard Hornsby Company in 1891 and built on a commercial scale under the name of the Hornsby-Akroyd oil-engine. Rights were purchased in 1898 by an American firm and in at least one model the design was modified with air-injection. While the Akroyd engine was the sire of the present low-compression oil-engine, vastly important development work was accomplished in this country, and the modifications thus resulting have been to a considerable measure responsible for the present-day success of the low and medium compression oil-engines.

Many thousands of engines varying from 6 to 350 h.p. were driving fishing-vessels, tugs, etc., in Europe long before this type became popular in this country and exceed Diesel engines in number. It was not until the early part of the war when foreign makers "poured in" these engines by the hundreds that additional domestic manufacturers, realizing the enormous demand in prospect, took up its construction vigorously for marine work. Since the early days many developments have been made to the design, but it was due to the enterprise of American firms that one of the greatest improvements was accomplished, namely, the elimination of the blow-torch for starting and running at light load and the substitution of the neat and safe electrical-ignition plug. One form of this device consists of a coil of special wire heated by electrical currents on to which the charge of oil is sprayed by the injector. Modern methods have otherwise improved all phases of the flexibility and smoothness of operation of the engine. Engineering never stands still, as has been well demonstrated by the many great improvements which have been made since the inception of the surface-ignition oil-engine especially during recent years.

There are distinct fields of usefulness both on land and sea for the surface-ignition oil engine, which is attractive for its simplicity of construction and operation, particularly for those numerous recent improvements which have further increased its adaptability and flexibility. Impressive endorsement of this viewpoint is made by the fact that a well-known Pacific Coast firm, whose experience in the work-boat engine field extends over many years, are marketing such an engine after most thorough investigation. We refer to the Standard Gas Engine Co. of Oakland, Calif., which is almost as well-known on the Atlantic side of the Continent. Other companies are busily engaged perfecting similar engines for the marine industry, having recognized the future for the same.

COMBINATION ARRANGEMENT SOLUTION FOR BIG LINERS

IN giving further details of the proposed two 1,000 ft. liners, previously referred to by Homer Ferguson, President of the Newport News Shipbuilding & Dry Dock Co., Chairman Lasker of the Shipping Board stated that these ships would represent the most daring advance the shipping world has ever seen should the idea crystallize into actuality, and that the propelling power probably will be Diesel-electric or turbine-electric drive. While Diesel-electric drive may be considered for these 70,000 ton vessels, we doubt if any one would be bold enough to take the step at this time because of the huge sum of money involved in the machinery and its more or less experimental nature. At the same time the plan could be made practical. To be within Diesel powers of to-day it would mean turning the engine-room of the ship into a vast central station containing about 33 units of 3,000 b. h. p. or 50 Diesel-electric units of 2,000 b. h. p. each, but obviously this would not be seriously undertaken even although 850 tons of oil per day would be saved compared with turbo-electric drive. The largest Diesel-electric sets in service are two of 4,000 b. h. p., one in France and the other in Scotland. But these two are heavy, slow speed crosshead sets. In placing the limit per unit as 3,000 b.h.p. we are thinking of engines turning at 200-250 r.p.m. for the purpose of compactness and medium weight. In one German central station there are two 3,000 b.h.p. Diesel-electric sets of the slow-speed type.

However, there is no reason why a combination turbine-Diesel-electric arrangement of 100,000 shaft horsepower aggregate should not be carried out with every success, installing say six Diesel-electric sets of 2,500 b. h. p. each, which is the same power as some Diesels now being completed for the U. S. Navy Department, and the balance of the power in a turbo-electric plant. Compared with an "all turbo-electric" installation this scheme would effect a saving of 160 tons of fuel-oil per day, or about $8,000 per one-way Atlantic trip. When in port the Diesel engines could be used exclusively with considerable advantage from an economic aspect.

OUR NAVY AND DIESEL POWER

THERE are so many economical uses of the Diesel oil-engine that were it not for the limited funds appropriated by Congress it would be hard to understand why this type of power has not been more extensively adopted by the U. S. Navy, instead of virtually confining its use to submarines. It looks, however, as if a start has been made by Washington in the right direction as the new battleships MARYLAND, COLORADO and WEST VIRGINIA will have auxiliary Diesel engines for generating electric current for operating the lighting plants, winches, pumps, etc. when in harbor. Utilization of Diesel motors for this purpose is by no means a novelty because the British Admiralty adopted Diesel auxiliaries in 1905 when the first "Dreadnaught" was being designed, two 100 K. W. sets being fitted. Since then all British capital ships have had this power installed. And, as Engineer Vice-Admiral Sir. Geo. G. Goodwin said,—"the Diesel engine undoubtedly is an acquisition in a ship, a single installation using 35 tons of oil compared with 350 tons of coal for steam." All the principal German warships also had auxiliary Diesel-electric sets and recent issues of "Schiffbau" gave complete technical details of the numerous installations. In the new American warships two Busch-Sulzer 950 b.h.p. Diesel, 400 k.w., Diesel electric sets are fitted.

The advantage of Diesel-electric auxiliary machinery has by no means been properly appreciated or understood by shipowners. Even with existing steamers—both passenger and cargo—a change from steam to Diesel-electric power for the vessel's engine-room, and perhaps deck, auxiliary machinery would effect an important reduction in the operating costs. Such alterations could be made by shipowners who fear "to go all the way" and convert the entire propelling and auxiliary machinery. It would mean a saving in the port fuel-consumption of from 4 to 20 tons a day according to the size and type of ship. In addition the vessel would be able to operate all her service plant such as pumps, wireless, boat-gear, lights, etc. should her boilers be disabled through flooding of the engine-room or other cause. All the White Star and Holland-American Lines' vessels have a Diesel-electric emergency equipment, and two sets are now being installed on the LEVIATHAN.

SELLING THE BOARD'S DIESEL ENGINES

IN the summer of 1918 the U. S. Shipping Board Emergency Fleet Corporation decided to construct 36 Diesel-driven steel motorships of a special double-ended design with telescopic masts for the purpose of submarine evasion. For these vessels 72 Diesel engines were ordered, consisting of 52 of McIntosh & Seymour and 20 of Pacific-Werkspoor design. Before the contracts for the hulls were placed the Armistice was signed, so the vessels were never built. Considerable work, however, had been done on the Diesel engines, owing to the splendid energy which the manufacturers put into the work at the time. However, the Fleet Corporation cancelled the order for fifty per cent of the engines, leaving 26 to be completed by the McIntosh & Seymour Corporation and 10 by the Pacific

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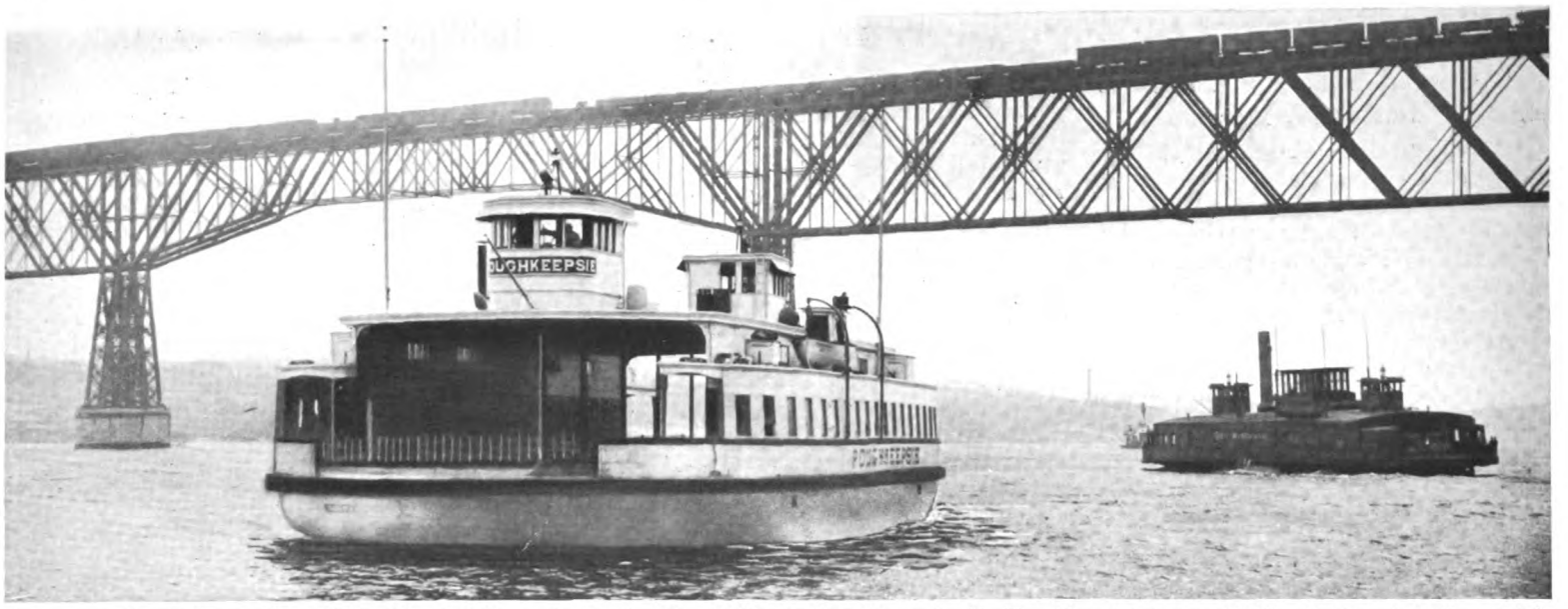


The new Diesel-electric ferry "Poughkeepsie" passing under the bridge at Poughkeepsie, N. Y. The Arconstruct-Hulfin design of hull certainly allows of an unusually clear and large deck space; and without question the particular types of both hull and machinery give remarkable maneuvring qualities. Note the old steam-driven side-wheeler to the starboard

Diesel Engine Company. These engines were completed in due course and most of them were put in the warehouses. Some of the M. & S. engines were purchased by private shipowners, such as the Vacuum Oil Company, and have been in successful service for several years.

It was only about a month ago that the Board made any determined effort to sell the balance of the engines, and they were advertised. This revealed that there was an active market ready to absorb practically every unit in stock. Their disposal was facilitated by the fact that the Shipping Board, realizing the shortage of motorships and the uselessness of many existing steamships, commendably arranged to sell a number of hulls at low cost on the understanding that they be converted to Diesel power. The following engines were sold last month at prices from $24,000 a piece upwards, which, of course, is very much higher than the figures which the Board recently received for reciprocating steam engines:—

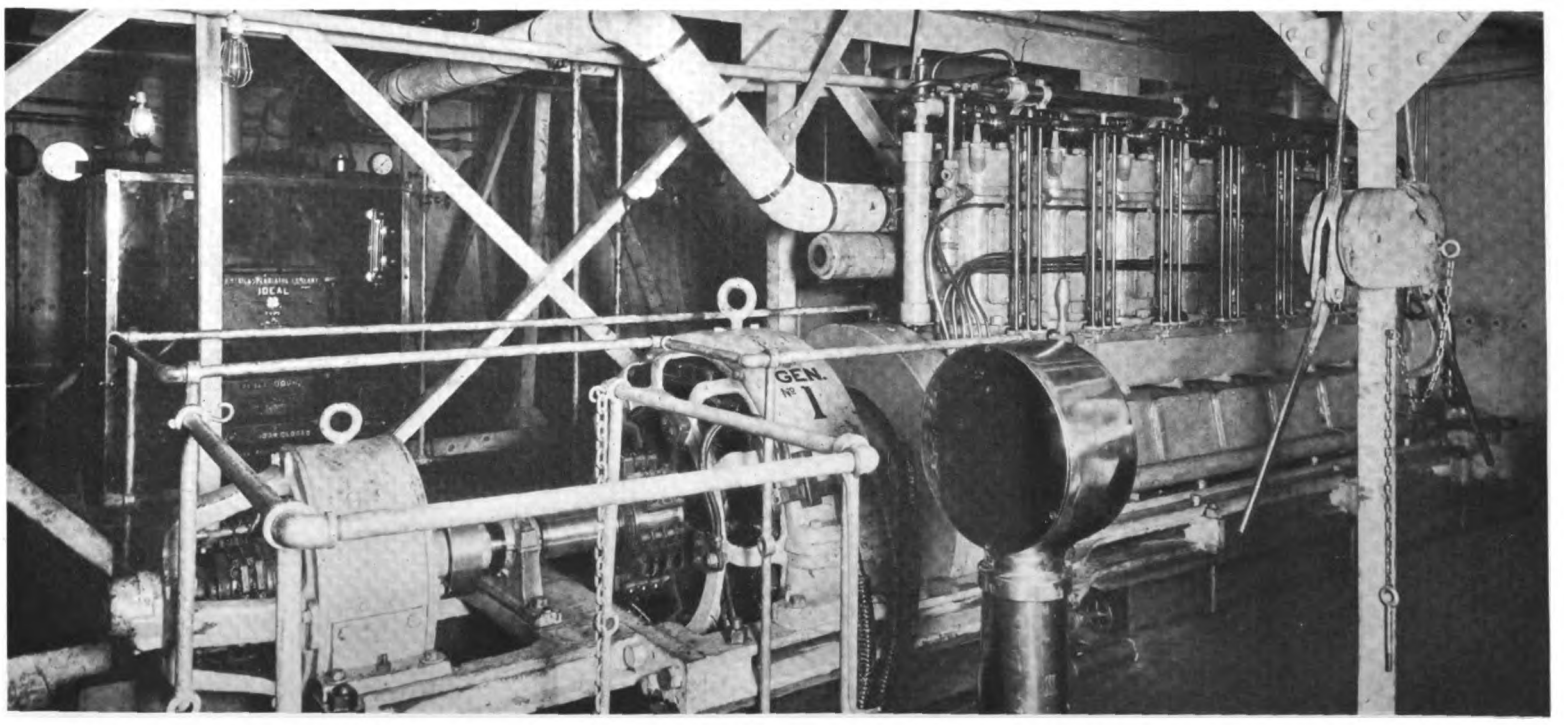
Purchaser	No. of Engines	Power of Engine	Make of Engine
U. S. War Dept., Washington, D. C.	13	900 b.h.p.	McIntosh & Seymour
Munson Line, New York City	2	900 b.h.p.	McIntosh & Seymour
Standard Oil Co. of Cal., San Francisco, Cal.	2	825 b.h.p.	Pacific-Werkspoor
Frank Lynch, Benson Lumber Co., San Diego, Cal.	3	825 b.h.p.	Pacific-Werkspoor
Federal Light & Trac. Co., San Francisco, Cal.	1	825 b.h.p.	Pacific-Werkspoor
Moore S. B. Co., San Francisco, Cal.	4	825 b.h.p.	Pacific-Werkspoor
Carey-Davis Towing Co., Seattle, Wash.	2	320 b.h.p.	Bolinder
	27	22,390 b.h.p.	Total

As it was known that sooner or later these Diesel-engines would be sold at less than market price their presence was a distinct deterrent to the Diesel-engine industry of the country; but this situation is now practically eliminated, because as we write there are only six Diesel-engines left for disposal.

TOMMYROT & DIESELS

UNDER the above heading in a recent issue, one of the New York shipping weeklies says:—"The idea that in the use of Diesel engines this country would be able to compete with the world's shipping is purely Tommyrot." The editor gives as a reason for this statement the fact that our rivals can acquire motorships quite as rapidly as we can and that the cost of operation under foreign flags as compared with our flag would be approximately as much in favor of the foreigner as the disparity is in steamship cost and operating expense. This seems an extraordinary view to take, and is it based on the assumption that America will stand just as much of a chance of having a successful merchant-marine if she goes on building steamships while foreign countries continue to build economical motorships? Or, does the editor mean that if America refrains from building motorships Great Britain and European countries will also refrain from their construction and will only build if we do?

Our contemporary apparently is pulling away at the wrong end of the string, so we reiterate that unless America soon has a large number of motorships she cannot hope to compete against the efficient European motorships with their big earning powers and low operating costs. Another point we would draw to the attention of the editor is that America has the advantage of great oil supplies both internal and adjacent, whereas European shipowners whose vessels are trading on the Atlantic have to import their oil in tankers or else purchase it from oil stations in this country. This is one advantage that American motorships would have inasfar as economical operation is concerned. Diesel oil at the Panama Canal today is $3.50 per barrel, but only $1.65 in New York and many foreign ships bunker at the Canal.



One of the Winton-Westinghouse Diesel-electric power sets in the engine-room of the ferry "Poughkeepsie." The hull was built by the Atlantic, Gulf & Pacific Co., of New York

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Among the Oil-Engined Workboats

Six Years' Operation of the Coastwise Motorship "Daniel M. Munroe"

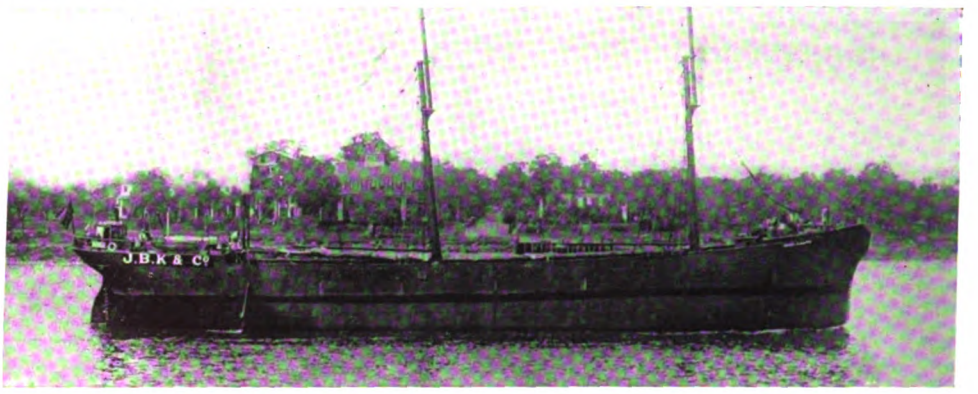
ONE of the coastwise vessels which regularly enters and leaves New York Harbor is the small steel coaster DANIEL M. MUNROE, owned and operated by the Newport Plaster Mining & Manufacturing Co. of Windsor, N. S., and which brings each month to the plaster works of J. B. King & Co. at New Brighton, Staten Island, New York harbor, about three cargoes of 1,800 tons of gypsum rock, which is the principal ingredient of plaster. Regular performances by this vessel are necessary for the continuous operation of the plaster works. On her trips between Windsor, N. S., and New York she occupies about 75 hours on a northbound trip light and 85 hours on a southbound trip loaded with 1,800 tons.

Capt. Andrew McDonald of the "Daniel M. Munroe"

The DANIEL M. MUNROE was built at Dumbarton, Scotland, by A. MacMillan & Sons, Ltd., in 1892, and is 220′ long, 35′ breadth and 21′ depth, and of 1,216 tons gross. In 1916 she was converted into a motorship by the Staten Island Shipbldg. Co. at which time the two 160 h.p. 16½″ by 18⅞″ two-cylinder hot-bulb type surface-ignition Bolinder oil-engines were installed together with a two K.W. electric-light generator driven by a 4 h.p. Fairbanks-Morse surface-ignition oil-engine, a Worthington general service pump, a donkey-boiler for steam heat, steering-gear, windlass, cargo winches and pumps. She went into service on June 14, 1916, and has been under the able command of Capt. Andrew McDonald.

Chief Engineer Fleming (on right), Mate Russell (center) and Asst. Eng. Riley (on left) of the "Daniel M. Munroe"

The DANIEL M. MUNROE has three-bladed cast-iron propellers of 72″ diameter and 48″ pitch which normally turn at about 200 to 215 r.p.m., giving the vessel a very moderate speed of about 6 knots. The round trip is about 1,200 miles and the fuel-consumption for this trip is about 3,700 gallons of 28 degree Baumé Texas or Tidewater oil. About five quarts an hour of Eureka gas-engine oil is used for lubrication, which quantity is somewhat reduced in the winter. Except for two winters during the war, those of 1918-19, the DANIEL M. MUNROE has made 18 trips each season and has never been delayed in entering or leaving port on schedule time by reason of engine trouble. During the war days her services were utilized in carrying coal from Norfolk, Va., to Providence, R. I., and in this service the U. S. Navy Department was particularly impressed with her economical and constant operation.



The "Daniel M. Munroe" before some changes were made to the deck structure

The DANIEL M. MUNROE has never been tied-up since going into operation six years ago and considerable credit for this service is due to Chief-Engineer William Fleming and his assistants, as well as to the builders of the engine. She carries a total crew of 14 men, of which the engine-room crew consists of one Chief-Engineer, one Assistant Engineer, two oilers and two donkeymen, although, of course, the latter run the coal-fired boiler and have nothing to do with the engine-room.

On page 434 of the June issue of MOTORSHIP is an illustration of the DANIEL M. MUNROE passing the CALIFORNIA, showing her auxiliary sail set, although at the time we did not know what vessel this was as it was impossible to read her name from the distance. The DANIEL M. MUNROE is a type of motorship which, perhaps powered a little higher, should be seen often in our coastwise fleet.

AMERICA'S PIONEER DIESEL-TUG

WITHOUT doubt the West Coast of this country has been most active in adopting the Diesel-engine for workboats; the first small Diesel-engine installations were made on Puget Sound waters about seven years ago. In the "Chickamauga," owned by the Pacific Towboat Co. of Seattle, Wash., was installed in 1915 the first Diesel-engine in an American tow-boat, this being a Nelseco Diesel-engine built by the New London Ship and Engine Co. of Groton, Conn. This was a four-cycle, four-cylinder 13 in. by 18 in. engine developing 240 h.p. at 240 r.p.m. and driving the boat eight knots. Her propeller is 75 in. diameter and 42 in. pitch. Her fuel-tanks hold 1400 gallons of fuel-oil, sufficient for about 153 hours operation. The "Chickamauga" is 70 ft. long, 18 ft. breadth and 11 ft. 6 in. draft.

Of this installation Capt. A. L. McNeeley of the Pacific Towboat Co. states that the operating costs are below the manufacturer's guaranteed minimum and that no serious trouble has occurred, simply minor replacements being necessary as in the case of any piece of machinery. He believes that motor-power is far superior to steam-power, that Diesel-engines can be operated by any capable engineer and that with this type the fuel and lubricating-oil cost is only about 11 per cent of the total cost of operation, whereas with an oil or coal-burning steam-plant this cost is about 45 per cent of the total operating cost. On account of the diversity of work done, periods of operation at full-power and intermittent periods of lying idle, the cost per hour of operation is not accurately obtainable. However, we have obtained a record of one period of seventy-five consecutive working days of operation which is typical and this reads as follows:

Hours towing	622
Hours running light	188
Total working hours	850
Total fuel-consumption	7,725 gals.
Total cost of fuel	$167.69
Fuel-consumption per hour	9.1 gals.
Cost of fuel per hour	19¾ cents
Cost of repairs	Nominal

Capt. McNealy further states in regard to the work of the "Chickamauga": "She has never lost a tow of logs and has been operated about 70 per cent of the time under load and about 20 per cent light. She has handled at times in one tow as many as fourteen sections, which considering the great size of Puget Sound lumber, indicates a heavy load." Log-towing is exceedingly heavy work, as the great log-booms offer the utmost resistance to motion, their great area and weight being especially unfavorable to maintaining any momentum even in still water, while against tide or river current the engine is put to most severe towing work.

"Chickamauga," the Nelseco Diesel-engined tug which has been in operation seven years

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Eleven Years' Operation of First Motorship

The Werkspoor-Diesel-Driven Tanker "Vulcanus" Has Voyaged Over 300,000 Miles, Although Only a 7-Knot Boat—Has Been in Constant Service for Nearly 12 Years

ONE of the things over which shipowners have had some doubt is that of the life of a Diesel-engine, which, of course, is as long as that of a steam-engine and much longer than that of a boiler if one may judge by the old oil-engines still in service on land and sea. This is endorsed by the performance of the tanker VULCANUS, owned by the Anglo-Saxon Petroleum Company, and placed in service at the end of 1910, or nearly twelve years ago. Historical interest is attached to this craft as she holds the record of being the first sea-going Diesel-driven motorship to be placed in service.

Through the courtesy of her owners we are enabled to publish the record of this vessel from the beginning of January, 1911, to December, 1921, or a total of eleven years. We figure that her single-screw engine must have turned about 4,816,224,000 revolutions, or 2,408,112,000 combustion in each of her six cylinders during that period. Her engine was the first crosshead-type Diesel ever constructed, and has six cylinders 15.748" by 23.622 turning at 180 r.p.m. It also was the first short piston engine, which is now in universal practice for crosshead oil-engines of the four-cycle type.

As the VULCANUS has only 480 shaft horsepower and a loaded displacement of 2,080 tons, her average speed for the entire eleven years of 6.26 knots may be considered good. Before giving the performance data we will repeat her general dimensions, viz.:

Loaded displacement	2,080 tons
Deadweight capacity	1,200 tons
Power	480 shaft h.p.
Engine speed	180 r.p.m.
Daily average speed	7 knots
Daily fuel consumption	1½ tons
Length	196' 0"
Breadth	37' 7"
Draught	13' 2"

The VULCANUS was built by the Netherlands Shipbuilding Company, of Amsterdam, Holland, and engined by the Werkspoor Works of the same city.

Her fuel consumption is particularly interesting. On her maiden voyage in 1910 she burned 2.35 tons of oil per day. This was reduced to 1.94 tons by the end of the first year, and by the finish of the fifth year it averaged 1.48 tons per day. The average for 1921 was 1.60 tons per day. This illustrates how the economy of a Diesel-engine improves after several years' service. Her average fuel consumption for the eleven years has been less than 1¾ tons per 24-hour day. Compared with a steamer this is an almost unbelievable economy, and should be specially noticed by operators and owners of coastwise vessels of similar tonnage.

The VULCANUS has always been operating in Far East waters, where repair facilities for Diesel-engines are by no means elaborate, so her record for the pioneer motorship is really remarkable.

M.S. "VULCANUS"
SPEED AND CONSUMPTION STATEMENT

Period.	Total time steamed. (Hrs. Min.)	Total miles run.	Average speed (knots)	Average Daily Fuel consumption (tons)
1911	2,271.05	16,039	6.95	2.044
1912	3,286.56	22,200	6.750	2.048
1913	5,469.01	36,021	6.600	1.663
1914	4,654.26	31,131	6.56	1.722
1915	4,605.15	29,856	5.60	1.481
1916	5,156.46	32,758	5.90	1.483
1917	5,522.30	32,283	5.841	1.595
1918	4,330.06	28,194	6.455	1.650
1919	4,905.35	31,625	6.23	1.633
1920	3,972.06	25,241	6.389	1.553
1921	3,606.10	24,180	6.787	1.607
Total to Jan., 1922	47,780	309,528	6.26	1.679 Average per day

AN ITALIAN SULZER-DIESEL TUG

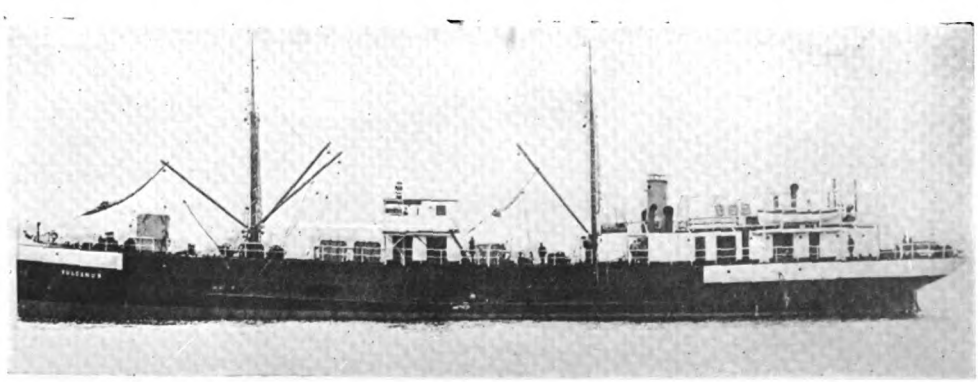
In many ports and on many rivers of Europe Sulzer Diesel-engines are employed in towing service, work that too many steam-tugs are doing in this country. While these foreign motor-tugs differ somewhat in appearance from our motor-tugs their Diesel-engines are earning for them enviable reputations for efficient work. The record of one of these, the ALBULA, is therefore interesting, doubly so because she performed valuable service during the war, towing large armed boats loaded with munitions right up to the front, work which required perfect reliability. This service was performed when the ALBULA was a part of the equipment of the Italian Royal Arsenal at Venice, where her 165 horsepower Sulzer two-cycle Diesel-engine was installed in 1918.

Frequently inspection of the engine parts indicated perfect condition and practically no wear of parts. After the war-service she was purchased by her present owners, the Cooperative Trasporti Portuali e Fluviali fra Padroni e Conduttori di Barche, of Venice. In the work of towing barges on the canals of that famous city perfect reversing ability is an absolute necessity, but she has never failed yet. Eight barges each holding about 125 tons can be towed up-stream at about 3 knots; when not towing she makes 9 knots with the engine running at 310 r.p.m. and 10 knots at 340 r.p.m. At the former revolutions when towing the fuel-consumption is 36 kilograms (79 lbs.) per hour and when running light it is 25 kilograms (55 lbs.). When towing at maximum load 1 kilogram (2.2 lbs.) of lubricating-oil is consumed, while not towing 0.6 kilogram (1.3 lbs.) is consumed.

Italian tug "Albula," powered with Sulzer-Diesel engine

MOTORSHIP "VULCANUS"—OPERATING DATA
(Other years not available. Vessel always in Far Eastern Waters.)

Year.	Days at Sea. Days.	Hours.	Loading &/or Discharging &/or Bunkering. Days.	Hours	Delay awaiting Berth. Days.	Hours.	Delay awaiting Cargo. Days.	Hours.	Sundry delays, including Sundays &/or Holidays. Days.	Hours.	Repairs (Including hull) or Drydocking. Days.	Hours.
1914	193	22	104	20	2	..	..	..	15	5	26	15
1919	204	9	79	7	..	16	..	..	5	..	44	6
1920	165	12	142	1	9	7	1	3	2	13	29	..
1921	150	15	131	5	12	15	..	..	4	9	45	7



"Vulcanus," the first Diesel-driven sea-going motorship placed in service

A BRITISH MOTOR COASTER

A motor-coaster which has been giving constant and economical service on the run between Norwich and Yarmouth, England, and Antwerp, Belgium, is the HEATHER PET. She is a handy little vessel of wood construction, 95 ft. long, 23 ft. breadth, 9 ft. depth and 8 ft. draft carrying 250 tons of cargo. With raised forecastle, long cargo-hold amidships and engine-room aft she is typical of the most efficient type of freighter for coastwise work.

ORDERS FOR ENTERPRISE OIL-ENGINES

The following companies have just ordered Enterprise Marine heavy oil-engines:

H. G. McLaughlin Co. of Seattle	60 h.p.
George Wallenrod of San Francisco	90 h.p.
Willard & Chas. D. Maxwell of Bellingham	65 h.p.
Washington Tug & Barge Co. of Seattle	125 h.p.

The 90 h.p. engine for George Wallenrod is to be installed in the 60' tug MYRTLE to take the place of her existing engines, while the engine for the Maxwell firm is to be installed in a small mail boat on Puget Sound. The 125 h.p. engine for the Washington Tug & Barge Co. will be fitted in a 90' steel tug boat, originally equipped with steam engines by the U. S. Government.

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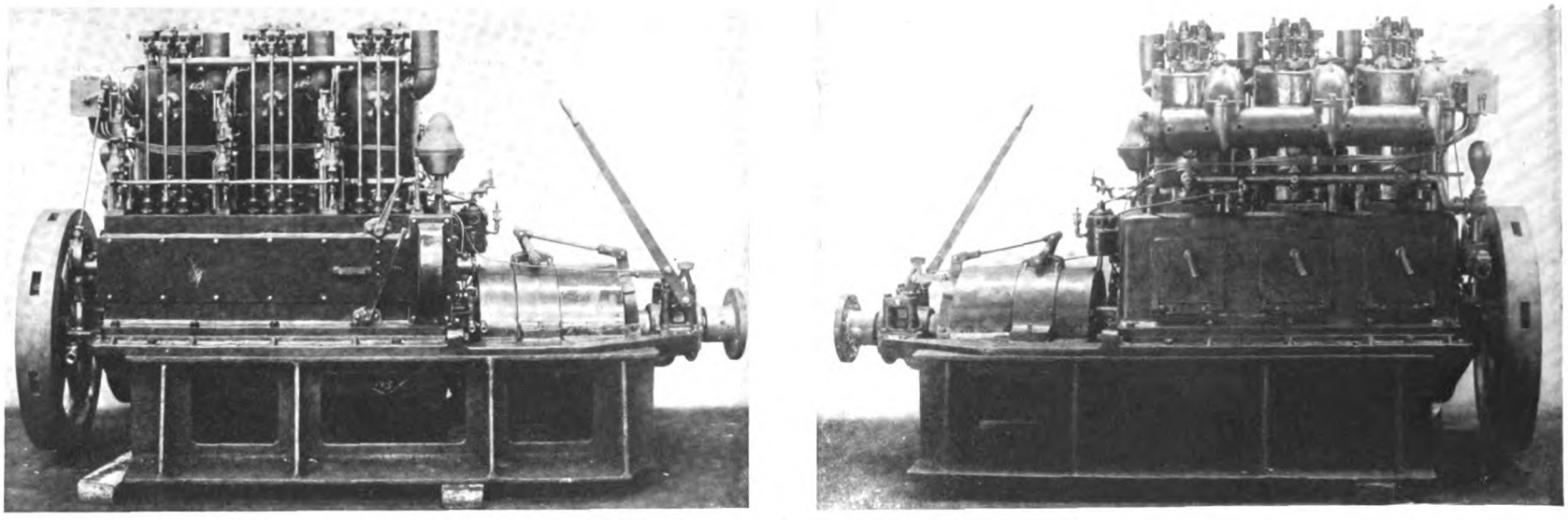


Inlet and exhaust sides of the new Wolverine oil-engine for workboats

Production of Workboat Oil-Engines in the East

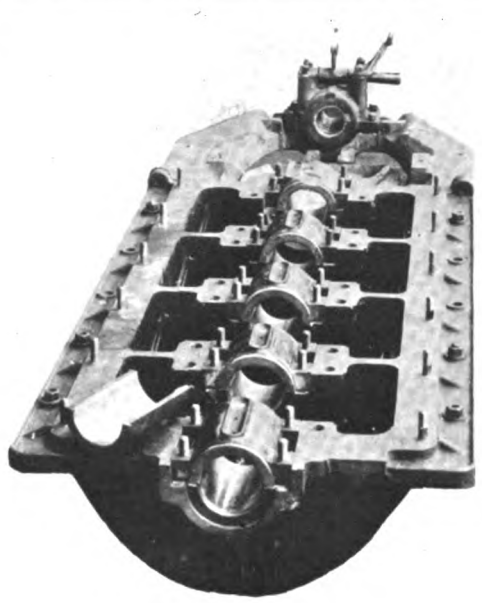
Details of the New Wolverine Airless-Injection Four-Cycle Marine Engine

ONE of the best known of American engines that for years have operated all over the world on gasoline, kerosene, distillate, alcohol and producer-gas is the Wolverine, manufactured by the Wolverine Motor Works, Bridgeport, Conn. In keeping with the trend of the day toward the use of engines burning heavier and cheaper fuel than those mentioned above, this company has for several years devoted considerable attention to the development of a heavy-oil engine, which has now reached the stage of actual installation and service. We recently took advantage of an opportunity to inspect one of these new oil-engines under construction and to witness a test at the factory, and are thus enabled to give our readers a first-hand description of this new departure of the Wolverine Company. As this engine undoubtedly will be adopted by workboat and yacht owners hitherto accustomed only to the operation of gasoline or kerosene motors, we will first give a short resumé of the working cycle.

This oil-engine is of the airless-injection—often called "solid-injection"—type operating on the four-cycle principle, modified from the Diesel cycle, and has no air-injection, hot-bulbs, hot-plates, carburetors or electric-ignition. The cycle of operation is as follows:

(1) *Suction Stroke:* Full charge of atmosphere is drawn into the combustion-chamber as soon as the intake-valve is mechanically opened and the piston moves downwards.

(2) *Compression Stroke:* On the up-stroke of the piston, with intake and exhaust-valves closed, the air is compressed to about 320 to 350 lbs. per sq. in., at which it becomes very hot. At a pre-determined point a portion of the air is super-compressed and thus raised to a higher temperature in a specially designed chamber (for which patents are pending), and this super-compressed air is violently injected in a whirling motion into the combustion-chamber, simultaneously with the injection of a finely pulverized oil-spray by means of a fuel-nozzle and a pump.



Bed-plate and main bearings

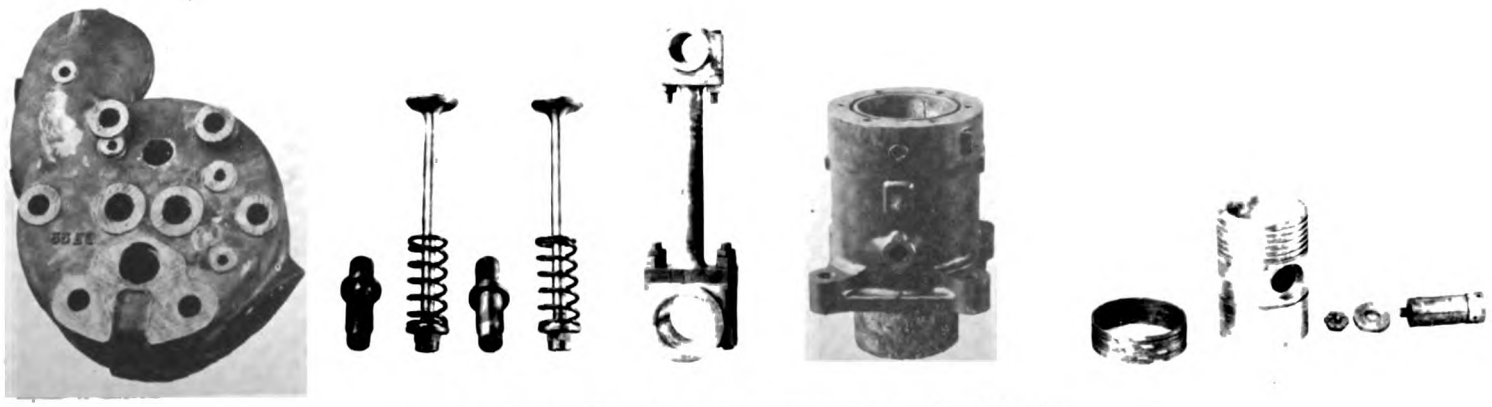
(3) *Power Stroke:* Combustion is instantaneous and the piston moves downward on its power stroke under the influence of the expanding gases.

(4) *Exhaust Stroke:* The exhaust-valve opens mechanically, following the combustion, and the piston on its upward stroke ejects the products of combustion. This cycle is then repeated.

Having in mind the world-wide distribution of these engines a broad range of fuels has been planned for and the engine is designed to burn successfully residual and semi-refined oils, as well as refined petroleum oils, such as kerosene, etc., shale-oil, etc. Using any of these fuels, the consumption in actual practice is 15 h.p. hours on one gallon of fuel, while the lubricating-oil consumption does not exceed one gallon for each 500 h.p. developed.

During the test which we witnessed remarkable flexibility and ease of control was noted, speeds ranging from the highest to just barely turning-over being instantly and positively regulated by a sensitive governor of the fly-ball type which controls the quantity of fuel-oil delivered to the combustion-chamber of each cylinder at each power-stroke by acting upon the stroke of the pump, maintaining steady operation, although the revolutions were quickly and widely varied when desired. The engine under test had four-cylinders, two of which were instantly cut out of operation without disturbing the steady operation of the engine, as each cylinder is a distinct unit in itself. A three-cylinder engine will steadily run on two cylinders or any two of a four-cylinder engine can be out of operation so that fuel-nozzles or other parts may be examined or changed without affecting the running of the boat.

These cylinders are of one size, i.e., 8¼" bore and 11" stroke, developing 23 h.p. in the single-cylinder engine; 46 h.p. in the two-cylinder; 70 h.p. in the three-cylinder, and 95 h.p.



Some of the component parts of the Wolverine marine oil-engine

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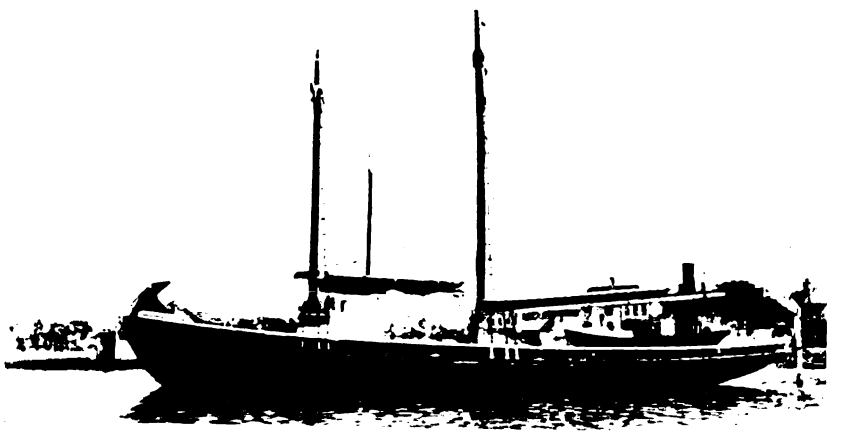
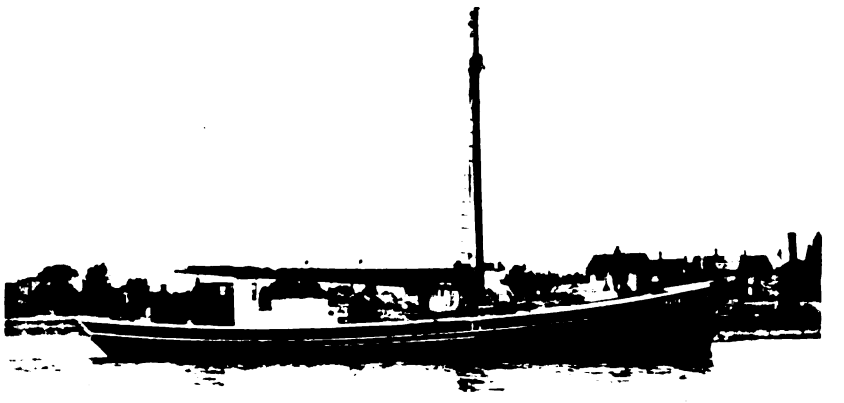


The "Mary A," powered with a 95 b.h.p. Wolverine oil-engine

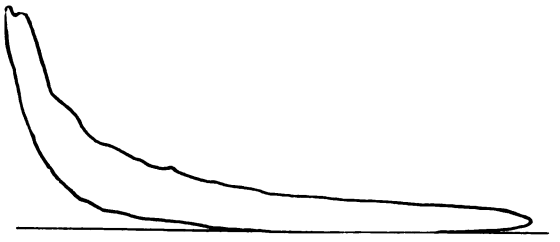


The "Irene," powered with a 70 b.h.p. Wolverine oil-engine

in the four-cylinder engine at 350 r.p.m. Constructed of close-grained grey-iron, they have ample water-jackets which effectually cool them, as we found that we could place our hand on any part of the engine and keep it there indefinitely. The cylinders are fastened to the lower frame by nickel-steel stay-bolts designed for many times any strain ever likely to be placed upon them. The cylinder-heads are one-piece castings and are water-jacketed, the water being by-passed outside from cylinder to head, and there is a groove in the upper end of the cylinder into which the head fits, being made tight with a gasket. In these heads are fitted the fuel-nozzle, air-starting, inlet, exhaust, and safety-valves. There are no storage-batteries, blow-torches or electric-plugs.

Fuel is supplied to the nozzle under heavy pressure by the fuel-pump and there is a filter and heater warmed by a portion of the exhaust-gases in a surrounding jacket, enabling the more sluggish oils to flow more readily. The filter consists of several removable trays which extract impurities from the fuel, and this filter and fuel-heater are regular equipment with all engines. Easily removable through the side of the engine-frame, is the camshaft carrying cams for the various valves which are turned out on an automatic machine from master-cams and are interchangeable; this camshaft runs in oil and rotates in exceptionally large bearings bolted to the frames.

In fact, throughout the engine bearings are exceptionally large, considering the output of the engine; the total lengths of the crankshaft



Indicator card of 3 cylinder Wolverine oil-engine at 10% overload

bearings of a single-cylinder engine being 22", those of the two-, three- and four-cylinder engines being 34¼", 46½" and 58¾", respectively. Crankshafts for all engines are 4¾" diameter and their bearings have upper halves of close-grain iron, lined with anti-friction metal and lower halves, being removable bronze shells, also lined with anti-friction metal, which shells can be replaced at little cost. Lubrication is by force-feed to the piston, thence to the opposite sides of the cylinders and to main bearings, etc., and can be adjusted closely.

Starting from stone cold is carried out by compressed air from a small independent compressor driven by a small single-cylinder Wolverine kerosene-engine, and stored in a tank. In addition there is a small air-compressor driven off the aft-end of the engine, which may be thrown in-and-out of action. There are also circulating-water and bilge-pumps fitted at the aft-end of the engine forward of the reverse-gear of Wolverine design and manufacture, extra large and strong. For ease in starting there is a cylinder-compression relief operated by a lever near the control-lever aft on the port side of the engine. These controls can be carried to the pilot-house if desired.

Compared with the Wolverine kerosene-engine built for so many years, we find that the space occupied by the new oil-engine, the weight and the price of this new engine are very little more than the older product, in some cases even less. Installations of this new oil-engine have been made in several fishing-craft, among them being the IRENE, which is a 61'x15'x5' boat with a three-cylinder 70-h.p. engine, swinging a 40" by 40" propeller, owned by Capt. Stanley Butler of Nantucket, Mass. Within six weeks after the installation of this first of the new type Wolverine engine Capt. Butler ordered two more of the same type, namely, 46 h.p. and 95 h.p. Another fishing-boat which also delivers her catch at Fulton Market, New York, is the schooner MARY A, owned by Capt. Shirley Nickerson of Nantucket, powered with a four-cylinder 95-h.p. engine. Capt. Joe Rocha of New Bedford, Mass., has a four-cylinder 95-h.p. engine in his sword-fishing boat, two 70-h.p. engines are being installed in other fishing-boats and another is ordered for fall delivery. Others have been shipped to foreign countries, so that it may well be considered that there is now available still another oil-engine for both commercial and pleasure-craft with which considerable practical experience has been obtained under ordinary workboat duty.

MOORE SHIPYARD WILL CONVERT FOUR STEAMERS

It is the intention of the Moore Shipbuilding Co. of San Francisco, Cal., to purchase four Lake-type steel freighters of about 3,200 tons each from the Shipping Board and convert them to motor power. In each vessel will be installed one of the four 850-shaft-h.p. Pacific-Werkspoor Diesel oil-engines, which they recently purchased from the Emergency Fleet Corporation. A. L. Becker, a consulting engineer representing the Moore Co., recently left San Francisco for the East for the purpose of inspecting and selecting the hulls.

It is proposed to remove all the existing steam equipment and install electric deck machinery, as well as direct Diesel drive for propulsion. An alternative is to utilize the steam deck equipment and leave one boiler in the hull.

In purchasing the Diesel engines, the Moore Co. stated that they furnished more speed and economy and greater cruising radius than steam engines, and as a result are the most economical power that can be applied to a ship. He predicted a revolution in the motive power of ships in the next few years, with the Diesel engine as the chief factor.

Officers and Engineers of Ships

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FIRST YEAR'S OPERATION OF THE "WILLIAM PENN"

The motorship WILLIAM PENN has now been in service one year, Aug. 7, 1921, to Aug. 7, 1922, writes Captain R. H. Wright to Rear Admiral W. S. Benson, Commissioner of the United States Shipping Board. At midnight, August 7, last, the vessel had traveled 44,781 knots and during the whole of this period, says Captain Wright, she has never made an involuntary stop, has suffered no break-downs of any sort and her repair bills total less than $100. Her average speed for the entire period was 11.16 knots, and her approximate average fuel-consumption has been 13 tons per day at sea, and 64 gallons in port.

In a letter to MOTORSHIP dated August 28th, written at sea, Oscar Olson, chief-engineer of the WILLIAM PENN, states that everything is going along "tip-top" and that they had no involuntary stop since leaving New York. He expects that the ship will be back the end of October. The WILLIAM PENN is of 17,000 tons loaded displacement and 4,250 i.h.p. She is propelled by Burmeister & Wain Diesel-engines installed at the Cramp Shipyard.

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Hesselman Airless-Injection for Small & Large Oil Engines

Further Details of Novel Method Devised by Prof. Hesselman on a 65 h.p. Engine Which Was First Described in Our June Issue

By EDVIN LUNDGREN

IT was previously mentioned that the principal difference between the system designed by K. J. E. Hesselman, of Stockholm, Sweden, and other systems of fuel-injection is that in the former only one fuel-pump is required regardless of the number of cylinders to be supplied and there is no complicated fuel-valve control-gear which distributes the fuel to the various cylinders. This is accomplished by having the plunger of the pump perform as many pressure-strokes as the number of required injections for all cylinders and distributing the fuel by separate mechanically-operated delivery valves. It is quite evident that the mechanical solution of this problem may vary according to the number of cylinders, the personal views of the designer, as well as to conform with the peculiarities of each engine, for this system is applicable to any design of high-pressure oil-engine. These distributing-valves may be actuated by separate cams on a common camshaft or by a crankshaft having the required number of throws or by a single cam which may be shaped according to the peculiarities of the pump-arrangement. Although the Hesselman system is simpler, yet each cylinder receives its proper supply of oil with absolute certainty.

The greater part of the experimental work which led to the development and perfection of the new injection system was carried out with a rebuilt four-cycle Diesel-engine developing 65 h.p. at 300 r.p.m. having two cylinders 10" by 14½". This was connected to a Heenan & Froude hydraulic dynamometer which had been carefully checked for correctness and the tests were carried out during March under the supervision of Prof. Hubendick of the Technical University of Stockholm, the writer having had the pleasure of witnessing same. The results are indicated in the accompanying table and diagrams. To obtain exact results in computing fuel-consumption these figures are based upon the total number of revolutions during each test, these being determined by a revolution counter thrown into action at the beginning of the test and disengaged at the conclusion of same. Two trials were run, on March 3 and 18, the fuel used on the first being that sold under the designation "galisol" which is regular Diesel-oil, while on the second trial ordinary boiler-oil was used, this test giving very satisfactory results apparently perfect combustion, the exhaust gases being colorless even at overloads, while no difficulty was experienced because of its use, it being heated to a proper state of fluidity by means of the heat of the discharged cooling-water. Samples of both well-strained fuels revealed the following characteristics:

	Galisol	Boiler-oil
Specific gravity at 15° C.	0.856	0.894
Calorimetric heat value	10,800 cal./kg. (19,440 B.T.U./lbs.)	10,710 cal./kg. (19,278 B.T.U./lbs.)
Effective heat-value	10,090 cal./kg. (18,162 B.T.U./lbs.)	10,010 cal./kg. (18,008 B.T.U./lbs.)
Viscosity Engler at 20° C.	6.08	
Viscosity Engler at 50° C.	2.03	
Impurities: Ash	0.04%	
Asphalt, insoluble in ether-alcohol 2:1	0.88%	
Asphalt, insoluble in gasoline of 70 S.G.	0.27%	
Solid matter	None	

Fuel consumption was measured by a gauge, a certain amount of fuel, determined by weighing, being added when the falling level of fuel left the point of a stationary needle until the moment when the fuel-level again reached this point. It will be observed that already with this experimental engine a lower fuel-consumption was obtained than with the best Diesel-engine of this power, the exact figures being 0.39 lb. at normal load, 0.397 lb. at ¾ load, 0.445 lb. at half load, 0.575 lb. at ¼ load, 0.404 lb. at 25 per cent over-load and 0.427 lb. at 33 per cent over-load, all figures being lb. per British brake horse power hour; the figures in the table are metric horse power. These excellent results are graphically presented in Figs. 1 and 2 with engine operating at constant and at varying speeds respectively.

The high over-load capacity deserves particular attention as the engine was able to carry 33-37 per cent over-load, at the former of which the exhaust-gases were still clear, thus indicating perfect combustion. At this load the mean effective pressure was 105 lbs. sq. in., while at the rated load this pressure was 76 lbs. sq. in. The mean indicated pressure was not determined because the indicator rig did not prove quite satisfactory. Nevertheless, a great number of indicator cards were taken which give a clear conception of the combustion process and of the pressures reached and some of these cards are reproduced herewith. The compression pressure is 405 lbs. sq. in., the maximum pressure at normal load is 584 lbs. and at maximum over-load is 626 lbs. sq. in. It is interesting to note that in taking these cards the pencil of the indicator was allowed to circumscribe the card several times, occasionally as many as twenty, and yet only one single clear line was obtained, thus indicating an excellent uniformity and regularity of the combustion.

The starting of the engine is accomplished by means of compressed-air, although the pressure need be only moderate; even at very low temperatures in the engine-room the engine could be instantly started and the full-load applied as soon as the brake could be adjusted, i. e., the necessary weights attached.

Fig. 3 shows one form of this Hesselman fuel-pump, this particular pump being intended for a six-cylinder four-cycle engine of 500 h.p. at 150 r.p.m. and it will be noted that the combination of six fuel-pumps in one single pump makes for simplicity and compactness. In this case the plunger is driven by a cam on a lay-shaft revolving as many revolutions as there are injections required per minute, i. e., 450. The lay-shaft is supported in ball-bearings and the pump-plunger is hardened and ground, lapped in its barrel, no special packing being required. In the design shown the stroke and consequently the speed of the plunger may be altered within certain limits. The effects of a higher plunger speed and a more rapid injection caused thereby is clearly shown in the indicator-card, Fig. 4, in which the length of the card corresponds to twice the piston-stroke as the motion of the indicator-drum is derived from the camshaft which, as generally known in a four-cycle engine revolves at half the engine-speed. The center-line of the indicator-card corresponds to the upper dead-center of the crank, while both the outer ends of the card correspond to the lower dead-center. In the card shown the higher pressure lines indicate a more rapid combustion as the direct result of an increased plunger speed.

In the design under consideration, the distributing delivery valves are actuated by means of their valve-stems or plungers which are also lapped in their guide bushings; this construction has been carefully selected so that the seating of the valve causes a certain pressure release in the supply-pipe to the cylinder, thereby insuring a reliable closing of the fuel-injection valve. The motion of the distributing-valves is derived from a common cam (not shown on drawing) which, by means of spur-gears, is driven from the lay-shaft. Provision has been made for putting one or another of the valves out of action if desired.

Below the drive of the distributing cam, on the lower end of the lay-shaft, a centrifugal-governor is arranged, the high-speed of the lay-shaft exerting only an advantageous influence upon the action of the governor, which by means of bell-cranks, rods and links shifts a sliding wedge and thereby determines the exact time for the opening of the suction-valve of the

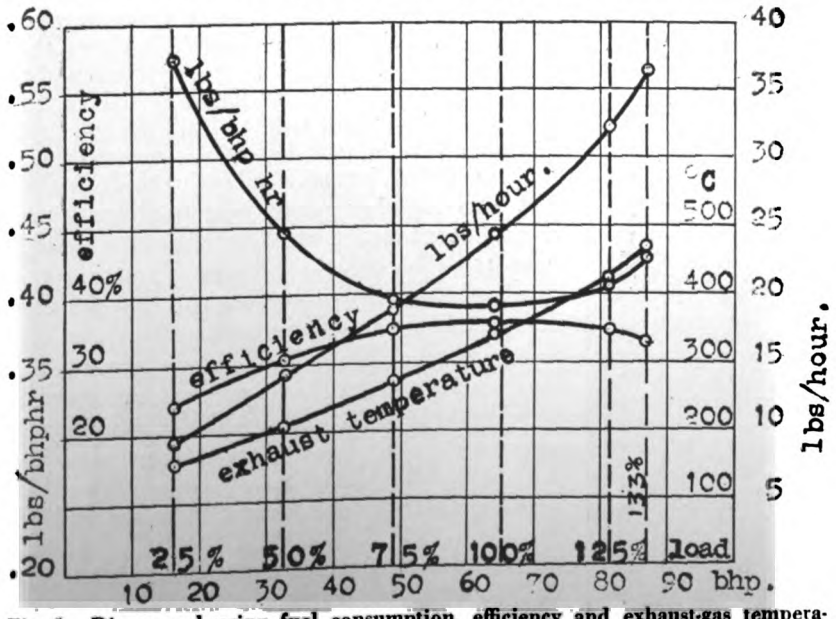

Fig. 1. Diagram showing fuel consumption, efficiency and exhaust-gas temperatures at different loads but constant speed

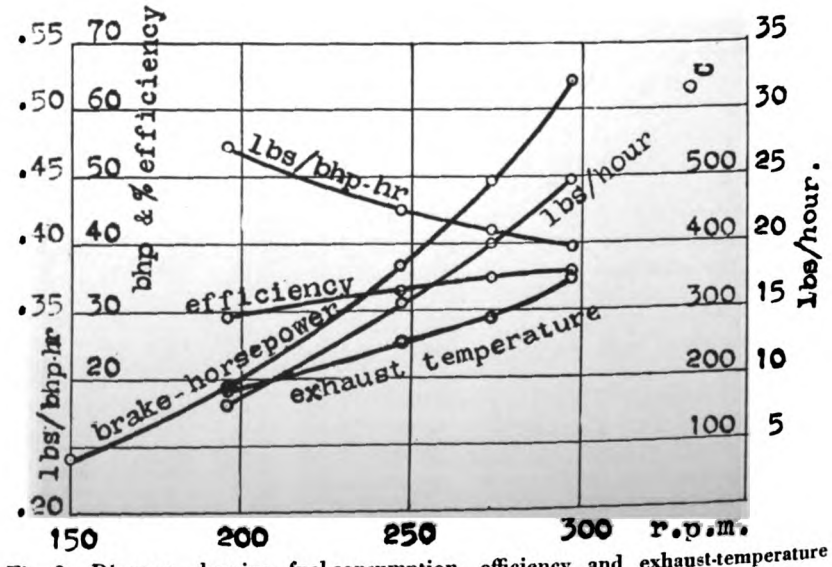

Fig. 2. Diagram showing fuel-consumption, efficiency and exhaust-temperature at different power but various speeds.

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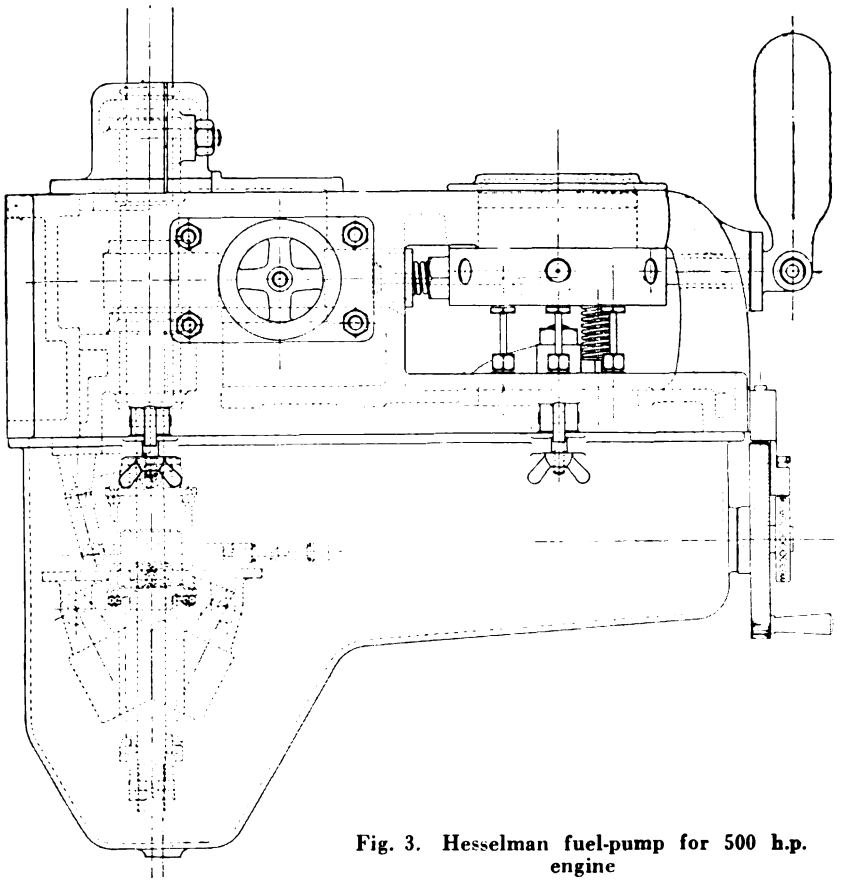


Fig. 3. Hesselman fuel-pump for 500 h.p. engine

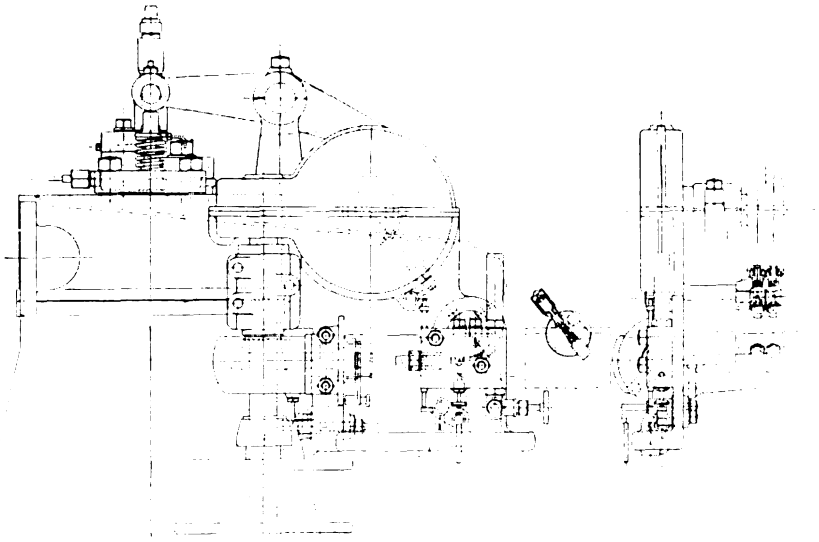
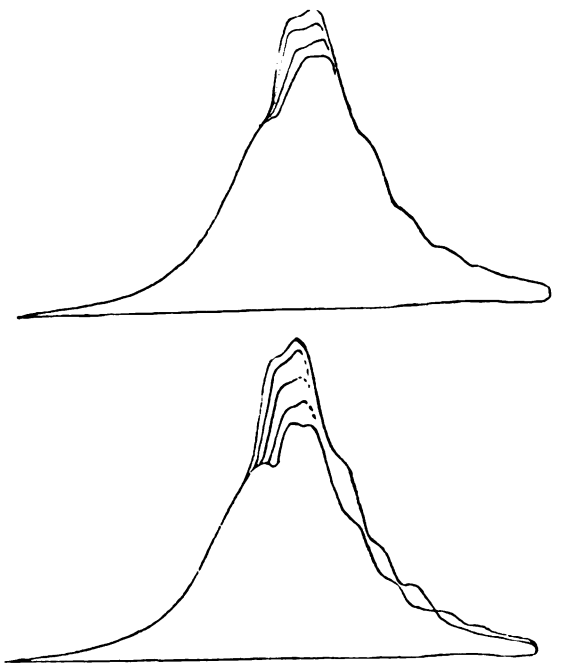


Fig. 6. Hesselman injection-system adapted to standard two-cylinder Diesel-engine

fuel-pump and thus indirectly also for the closing of the automatic fuel-injection valve. In stationary engines the governor varies the quantity of fuel delivered by the pump in direct proportion to the load in order to keep the speed constant; in marine-engines the primary object of the governor is to prevent racing of the engine while otherwise the speed of the engine is controlled by shifting the wedge by means of a hand-wheel shown in the lower right-hand corner of Fig. 3, the smaller knob of which wheel serves to vary the time of the injection and ignition, which in this manner may be changed as easily as in an atuomobile-engine. A series of notches will be noted on the rims of the hand-wheels in order to retain them in a certain position. Fig. 5 shows the influence upon the process of combustion as indicated on the indicator-cards of changing the time of injection.

Another very interesting variation of the pump-design as applied to a standard two-cylinder, four-cycle Diesel-engine is shown in Fig. 6, in which case the pump-plunger is driven by an eccentric on the vertical intermediate shaft and the suction-valve is controlled by an axial governor, while the distributing delivery-valves are actuated by cams on the regular camshaft. Particular attention is called to the simple shape of the pump-body, which consists of a steel forging and has a round part containing the distributing valves and a square head, somewhat off-set, which houses the plunger and the suction-valve. It is practically always possible to obtain such a shaped pump-body in order to enable this part to be a steel-forging. Together with mechanical simplicity of the operating gear and regulating mechanism this single pump has the further advantage of compactness without sacrificing reliability.

To insure perfect reliability of the pump the



Figs. 4 (upper) and 5 (lower). Indicator cards showing effect of varying linear speeds of fuel-pump plunger and changing time of injection and ignition

fuel is supplied by a feed-pump of liberal dimensions which forces the fuel-oil through a high-pressure filter of patented design. In this filter the oil is led through a number of longitudinal grooves cut in the circumference of a cylindrical body from which it can reach similar grooves opening toward the discharge-end of the filter only by penetrating the small clearance provided and this does not permit any matter thicker than 0.001 inch to pass. As the oil in all oil-engines is usually very well strained and filtered and clean before reaching the feed-pump it should require long regular service before the whole clearance would be clogged with impurities. A second filter is provided for use when the other is removed for cleaning and a pressure gauge is provided which immediately warns the engineer when the filter becomes filled with impurities to such an extent that resistance to free flow of the fuel is produced. To equalize this flow there is an air-chamber and there is also a smaller filter fitted in the fuel-valve body, which filter, referred to in the previous article, is of particular value as long as the fuel-pipes are new as there is a possibility that dirt and scale from the inside of the pipe and joints may be carried along by the fuel, although such piping is cleaned as thoroughly as possible.

Not only because of this, but because the inside diameter of the fuel-piping is calibrated by a special process and the surface made perfectly clean and of true diameter, is this cleaning of value. The hydraulic-resistance, the true diameter of the pipe, the motion of the pump-plunger, the opening of the various valves, indeed all the factors which might possibly exert an influence upon the pressure and flow of fuel through the pipe were made the subject of the most careful and painstaking investigation and the results were incorporated in the engine. Variations of the pressure-wave within the pipe were recorded by means of an optical indicator. Other valuable data were secured by experiments made to determine the time elapsing between the beginning of the delivery by the pump, the opening of the injection-valve, the injection and ignition.

The high grade engineering work which has been done personally by Prof. Hesselman with the use of all the scientific means available and the valuable research work done has been rewarded with the success which is so deserved.

OIL ENGINES ARE RAPIDLY GAINING IN FAVOR IN
THE WORKBOAT FIELD
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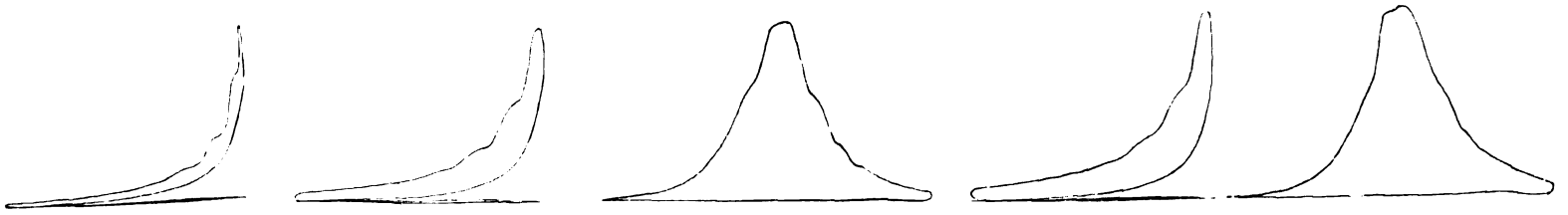

Fig. 7. Various indicator-cards of Hesselman test. Reading from the left they show operation at quarter-load, two at rated load and two at 33 per cent overload

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Utilization of Exhaust-Gases

An Investigation of the Possibilities of the Effective Use of Waste Heat

By S. SNUYFF

IT is the general view of the engineering world that in the slow-speed Diesel-engine the peak of fuel-economy has practically been reached and that further gains of importance will hardly be attained in the near future. However, such belief fails to credit the possibilities of utilizing the heat of the exhaust-gases, which have already been applied for developing auxiliary steam, for cooking, for hot-water service, and for heating fuel-oil. In the December, 1920 issue of MOTORSHIP on page 1095 were mentioned the possibilities of heating motorships by steam raised in a boiler heated by exhaust-gases. As these, when the engine is working at full-load, contain a rather high percentage of the total heat-value of the fuel it may prove an economical method to utilize this heat not only for minor purposes such as cooking, heating and evaporation but for generating power as well, as in the Still engine. Exhaust-heat from internal-combustion engines has already been utilized in Europe on a fairly large scale in connection with large stationary gas-engines and there seems to be no practical objection to adopting this practice in the marine field, especially with high powered installations.

The heat-balance of a well-designed, slow-running, high-powered four-cycle Diesel-engine may be assumed to be as follows:

	Per Cent.
Incomplete combustion	1
Turned into Effective Work (B.H.P.)	34
Lost in Friction	8(1)
Lost in cooling-water (or oil)	6(2)
Lost in heat conductivity and radiation	1
Contained in exhaust-gases	46
End-pressure	4(3)
Total heat	100

Using these figures as our basis we will investigate the increase in power which is possible, expressing this as a percentage of the effective horse-power of the main-engines.

(1) The loss by friction in an engine having a mechanical efficiency of 72 per cent. is actually 13.2 per cent. of the total heat, but piston-friction, which is about 40-50 per cent. of the total, is transformed into heat absorbed by the gases and cooling-water. Also, in engines taking fresh air from the crankcase the heat developed by bearing-friction is mostly imparted to this air and is therefore contained in the exhaust-gases.

(2) In two-cycle engines the heat transferred to the cooling-agent is greater than this figure, thus reducing the amount of heat contained in the exhaust-gases.

(3) A great part of this energy is transformed into heat by friction in the exhaust-mains, etc., which is neglected in the calculation.

It is the writer's opinion that the most economical way to utilize the exhaust-gases will be to lead them through a steam-boiler, generating steam to be used in a steam-engine, either reciprocating or turbine type, with a condenser. It is possible to apply this principle without using a separate engine, as the main Diesel-engines can be built so that the steam is used on the opposite side of the engine-pistons as in the case of the Still engine. While at first sight this arrangement seems better than installing a separate engine because of thereby avoiding the greater part of the frictional losses of the steam-engine it appears upon closer consideration that in order to avoid cooling of the cylinder-walls of the steam-end of the engine that the cylinders are elongated to a great extent. If they were not, the thermal-efficiency of the steam-system would be badly affected. Moreover, the cooling of the piston presents difficulties and the question of the correct cylinder-proportion seems difficult to solve. Therefore, without discussing the possibilities of the Still principle it seems best to base our calculation on the ordinary steam practice, its efficiency being well established by numerous experiments.

The first proceedure is to ascertain the efficiency of the boiler to be used, as upon this depends to a great extent the temperature of the exhaust-gases. Assuming that the exhaust-header is constructed in the form of a steam-boiler situated immediately aft of the engine and as close as practicable to the cylinders the temperature of the gases at full-load and mean-effective pressure of about 100 lbs. per sq. in. (7 KG/cM²) will be about 800 degrees F. (425 deg. C) when entering the boiler. Assuming also the following figures:

Steam-pressure	175 lbs. per sq. in. (12 Kg/cm²) abs.
End-temperature of gases	385 deg. F. (195 deg. C)
Cycle-air temperature	60 deg. F. (15 deg. C)
Boiler-radiation loss	2 per cent.

the efficiency of the boiler will be:

$$\frac{(800-60)-(385-60)}{(800-60)} - 0.02 = 0.54 \text{ or } 54 \text{ per cent.}$$

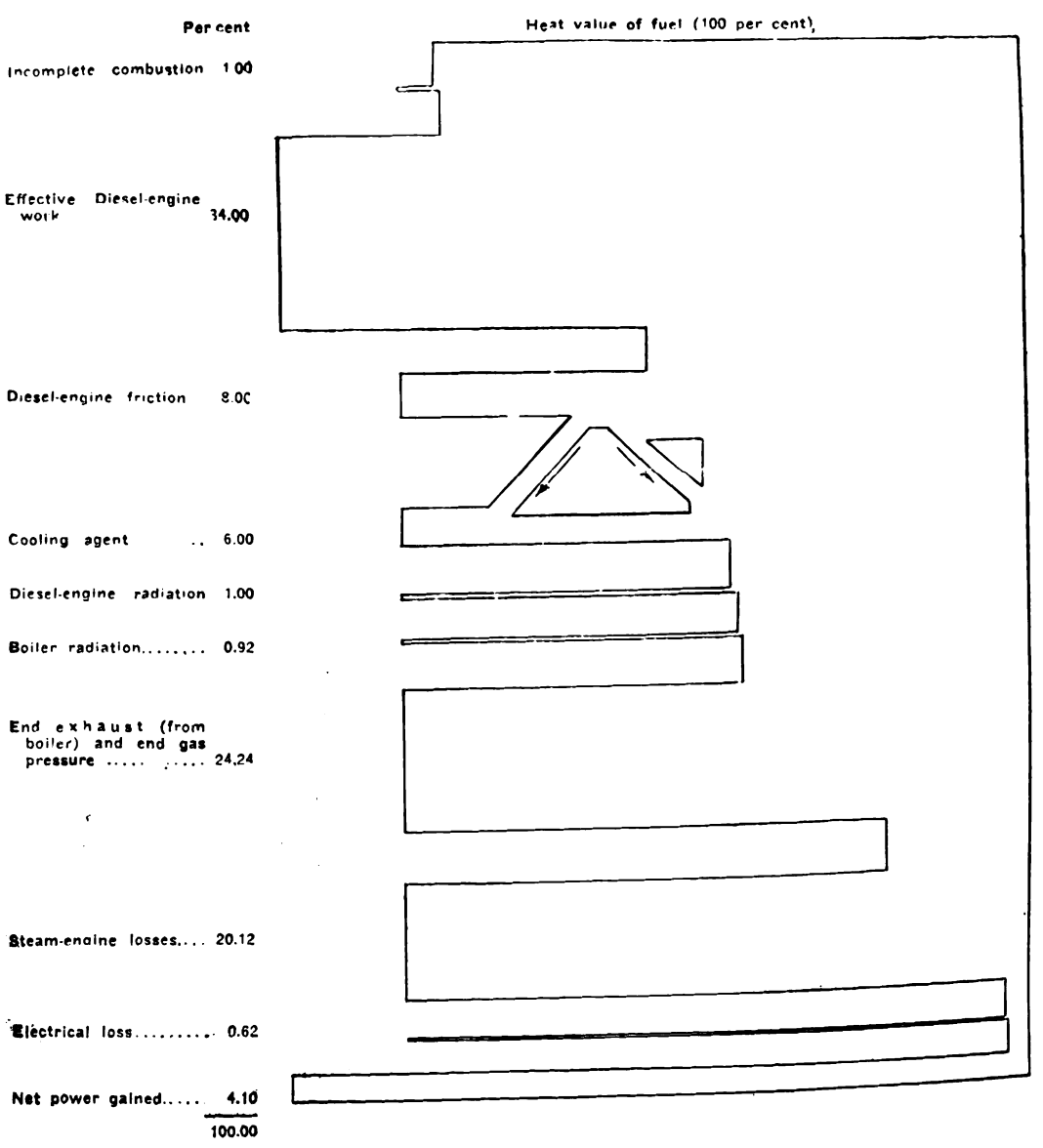
The heat-balance for the boiler will then be as follows:

	Per cent. of exhaust-heat	Per cent of fuel-heat
Radiation-loss	2	0.92
End-exhaust heat	44	20.24
Turned into steam and feed-heating	54	24.84
Exhaust from engine	100	46.00

In order to judge the efficiency of the steam-engine to utilize the steam which we plan to generate it is necessary to choose between the reciprocating and turbine types and then the type of drive, whether direct (which is only possible with the reciprocating-type) or by electric-transmission. Although the steam-turbine running at its most economical speed can be regarded as more economical than the reciprocating-engine both as regards weight and fuel-economy, however, because of excessive wear and noise which geared-turbine drive in connection with a Diesel-engine would entail, we cannot recommend its application here. The difference in tempo of the Diesel and the turbine-engine would probably cause frequent break-downs as well.

Should the turbine be selected however, the most practical method of transmitting its power to the Diesel-engine would be electrically by constructing the latter with the flywheel in the form of a motor, thus avoiding separate electrical-equipment. The thermal-efficiency of the turbine being assumed to be 19 per cent (on a B.H.P. basis) with a turbine of about 400 to 500 B.H.P., a steam-pressure of 175 lbs. (12 atm.) abs. and a superheat of 210 deg. F. (98 deg. C), the electro-thermal efficiency (assuming an electrical loss of 13 per cent) will be 0.19 x 0.87 = 0.165 or 16.5 per cent. The thermal-efficiency of a well-designed compound or uniflow engine will be about 16-17 per cent under the same conditions. Therefore, because of the saving of weight and space as well as the opportunity to use the power developed for electric-lighting, the turbo-electric drive is preferred. The

GRAPHICAL BALANCE SHEET OF GAINS AND LOSSES IN EXHAUST HEAT-UTILIZATION SYSTEM



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balance-sheet for the steam-installation with electric-transmission will be as follows:

	Per cent of steam-heat	Per cent of exhaust-heat	Per cent of fuel-heat
Condensation, radiation and friction-losses	81.0	43.74	20.12
Electrical-loss	2.5	1.35	0.62
Effective-work (increase)	16.5	8.91	4.10
Boiler-steam	100.0	54.00	24.84

As the thermal-efficiency (based on heat-units turned into effective-work as given in our first table) of the Diesel-engine is 34 per cent the increased power figures as follows:

$$\frac{0.041}{0.34} = 0.12 \text{ or } 12 \text{ per cent.}$$

This indicates that by installing an effective steam-boiler with superheater, feed-water heater, etc. utilizing the exhaust-heat of the engines and generating steam, connecting this to a turbo-electric set which delivers power to a motor direct-coupled to the main-engine the power can be increased by about 120 H.P. for every 1,000 B.H.P. of the main-engine. Basing the total output of this installation on the power required, the horse-power of the main-engines can therefore be reduced to 893 for each 1,000 S.H.P. required and the fuel-consumption per S.H.P. will be cut down about 10.7 per cent so that the figure becomes 0.375 lb. per S.H.P. hour instead of 0.420 lb. This is perhaps more clearly indicated in the illustration herewith.

It will now be in order to consider the details of such steam and power-generating equipment. It has already been stated that the exhaust-mains should be as short as possible and that it would be good practice to construct the exhaust-header as a boiler. It is of great importance to keep the cooling-losses as small as possible. The feed-water is already heated by the exhaust-gases and so the cylinder, piston and exhaust main cooling-water cannot serve for this purpose. There are difficulties to be solved, of course. As to deterioration of boiler-plates by the corroding-action of the exhaust-gases this will certainly not be greater than that caused in the ordinary oil-burning boiler, where the plates are subjected to temperatures beyond those that would exist under this system we recommend.

The chief difficulty of the whole problem lies in the design of the boiler, which in view of the temperature gradient being smaller than that of the ordinary boiler requires greater surface for a given quantity of steam because the heating-surface depends upon the mean temperature gradient (the difference between the starting and end-temperature) in an inverse ratio. So the boiler will be somewhat bulky and as it must be installed close to the Diesel-engine consideration must be given to providing accessibility to the same for overhauling and repair. Here we have a wide field for the inventive skill of engineers and no doubt these difficulties will be successfully overcome when they have attacked the problem. Regarding the type of turbine to be used, the several various systems now known are applicable, but, because of the fact that the writer believes that the thermo-dynamic efficiency of this type is better than others of given size, steam-pressure, etc. and guide-blade losses are avoided, the Ljungström-system turbine is best suited for use on board ship. In this system the blades are arranged on two opposite disk-shaped rotors, the blades of each serving as guides for the others. While in ordinary marine practice this system has the disadvantage that every turbine has two shafts turning in opposite directions. When, however, this turbine is used for generating electricity this peculiarity is not harmful, one generator being coupled to each shaft and the whole set is compact and light.

The cost of such heat-utilization systems is influenced greatly by the large heating-surface needed for the steam-raising plant; another item of cost is the rather large size of the electric-motor direct-coupled on the main-engine shaft because of the slow-speed. On the other hand, the cost of building the plant is compensated by the fact that part of the machinery can be constructed as a steam-plant, which is in general less expensive to build than Diesel-machinery.

In two cases the question of the motor utilizing the current gained is not of importance, first, when the current is used for auxiliary purposes such as lighting, steering, refrigerating, ventilating, pumping, etc., and secondly, when Diesel-electric propulsion is adopted. In the latter case the utilization-system shows still greater advantages than in the case of direct-drive. The electric-transmission losses being a part of the main-system, the full power of the steam-plant can be regarded as a gain which is estimated to be 13.8 per cent as follows:

$$\frac{0.46 \times 0.54 \times 0.19}{0.34} = 0.138$$

It is rather interesting to consider the merits of this system in connection with such a high-powered Diesel-electric liner as is anticipated by far-seeing men. Better efficiency may be expected than with plants based upon steam-installations now in use, where the power is in the thousands, while in our system the boilers being of smaller size are easier to care for. For this liner the following figures are prepared:

Shaft horse-power 15,000
Efficiency of electric-transmission...91 per cent.
Total horse-power 16,500
Exhaust-gas temperature at engines..800 deg. F. (425 deg. C)
Percentage of heat contained in exhaust-gases .....46 per cent.
Boiler steam-pressure .....175 lbs. (12KG) abs.
Steam-temperature.....607 deg. F (320 deg. C)
Feed-water heating 60-370 deg. F (15-187 deg. C)
Cycle-air temperature ...60 deg. F (15 deg. C)

The gases will leave the boiler at a temperature of about 295 deg. F (145 deg. C) and its efficiency will be:

$$\frac{(800-60)-295-60)}{800-60} = 0.02 = 0.66 \text{ or } 66 \text{ per cent.}$$

With a steam-turbine of about 2,500 H.P. a thermal-efficiency of about 22 per cent could be anticipated so that the gain in power will figure out

$$\frac{0.22 \times 0.66 \times 0.46}{0.34} = 0.197 \text{ or, say, } 19 \text{ per cent.}$$

The total horse-power of 16,500 will be proportioned as follows:

		or approximately
Diesel-engines	13,850 H.P.	14,000 H.P.
Steam-engines	2,650 H.P.	2,500 H.P.
Total horse-power	16,500 H.P.	16,500 H.P.

To produce this power the fuel-consumption will be:

$$\frac{14{,}000 \times 0.42}{15{,}000} = 0.392 \text{ lbs. (0.177 KG) per shaft H.P.}$$

It now remains to see if the advantages are not purchased by such an excess of weight of machinery that it would prevent its application. Already it has been pointed out the small steam-raising capacity per unit of heating-surface of the "heat-utilization boiler"; in fact, we cannot credit more than about 1.2 lbs. of steam raised per sq. ft. of heating-surface. Therefore the boiler should have a heating-surface of 17,000 sq. ft., assuming the steam-consumption of the turbine to be 8 lbs. per B.H.P. The weight of the boiler with water, superheater and feed-water heater can be liberally estimated to be 180 tons; the turbine with generators, condensers filled with water, and auxiliaries will weigh approximately 50 tons. Thus the total weight of the steam-plant is about 230 tons, of which some 50 tons is water, the machinery-weight being about 180 tons. If we assume the Diesel-engine to be of the medium-speed type, weighing not more than 180 lbs. per B.H.P., the weight of this type of engine required to produce power equal to that of the steam-plant, i.e., 2,500 H.P., would be $180 \times 2500 = 450{,}000$ lbs., or about 200 tons.

Emphasis has been made that the chief difficulty is with the design of an effective boiler, and this will certainly not be less in the case of a high-powered plant where the gases from a multitude of cylinders have to be utilized. The question arises whether these gases will be led to a single boiler or whether each cylinder will have its own boiler with superheater and feed-water heater. Decision then has to be made whether the heat shall be led through the pipes or outside of them; possibly a combination of these two will be adopted. The solving of such problems presents difficult but interesting tasks.

When the gases are led outside the pipes the water-tube boiler can be regarded most favorably as regards weight, although some difficulty will arise with this type because it will require brick-lined shell and because of its small water-capacity. Gases can be led directly into the shell. With gases flowing through the tubes it will form to some extent the locomobile-type boiler (without gratings, etc.), and if gases from several cylinders are led to this boiler it will have a large water-capacity and increased weight and some difficulty will be experienced in getting a favorable system of collecting the gases from the separate cylinders without great losses by cooling.

Giving each cylinder a separate boiler will facilitate connection of the boilers to the exhaust-outlets, but will increase weight and radiation-losses in addition to the difficulties of maintaining an even water-level.

Before concluding this article there is a matter of great interest in connection with this utilization-principle to be referred to. It is well known that the mean-effective pressure of the internal-combustion engine can be raised by "supercharging," in other words, by charging the cylinder with air under pressure. In ordinary practice this causes a loss in fuel-economy as the end-pressure is raised as well. In the "exhaust-heat utilization system" the gases leave the boiler under the same pressure as they leave the cylinders (the volume is lowered of course because of the temperature drop) and, after being cooled, can be used to drive a gas-turbine, thus utilizing their pressure. Thus a great part of the energy lost in raising the end-pressure in the cylinders is gained by means of an engine that is very light (thus adding little to the weight of the installation) and supercharging becomes an economical method of reducing fuel-consumption per B.H.P. On the other hand, the weight per B.H.P. is substantially decreased by the application of this system as this weight diminishes in direct-ratio with the mean-effective pressure. This subject of utilizing the exhaust-heat of Diesel-engines offers a wide field for study and investigation and when properly considered may prove to promote the development of the large motor-liner.

[In Mr. Snuyff's article there are many problematical and theoretical aspects on which other engineers may have alternative views, so our pages are open to letters discussing the subject.—EDITOR.]

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Testing a 1000 Shaft H. P. Marine Oil Engine

Builders of the "Camellaird-Fullagar" Diesel Engine Release Some Most Interesting Information

Part II

(*Continued from page 693 Sept.*)

IN addition to this trial it was thought that a test under tropical conditions would produce interesting data and for that purpose the scavenge air intake was connected to the shop heating system. An average temperature of 102.3°F. was maintained throughout the trial and the cooling-water inlet temperature was also raised in proportion by by-passing some of the outlet water into the suction tank and thus maintaining the inlet temperature of 91.8°F. The injection-air compressor suction was coupled to the scavenge-air belt and the temperature of this air remained in the neighborhood of 140°F. throughout the test.

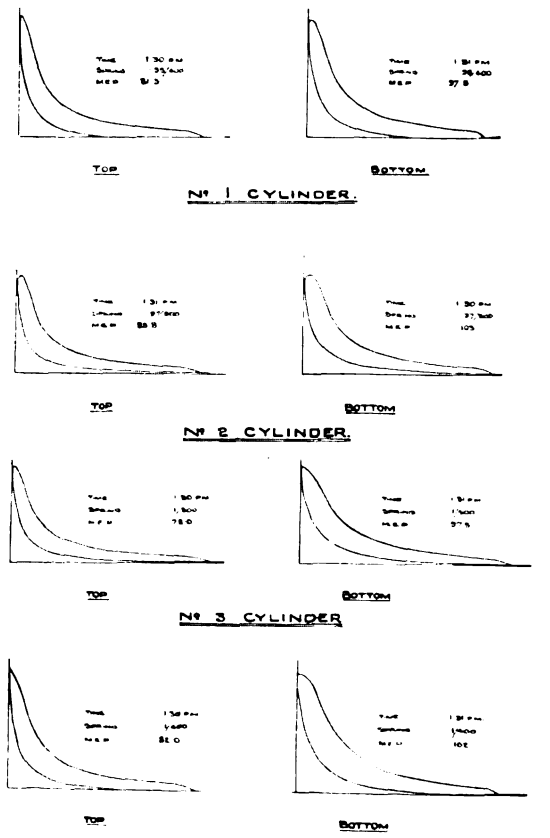
The results obtained on this test are published in Table No. II giving again as in the previous instance the average results of the whole three days together with the results with the best fuel consumption for a short period. The fuel used was similar to that used in the previous test and the above quoted specification also applies in this instance.

The question of the utilization of heavy fuels is of primary importance today and by including a test demonstrating the flexibility of the engine with regard to a wide range of various fuels, Cammell Laird & Co. have added valuable information to this subject. There appears to be considerable controversy as to whether any advantage accrues from the use of heavy fuels; in fact it has been suggested in certain quarters that there are ample supplies of gas-oil (solar-oil) available, thus obviatnig the necessity of the engine being capable of burning residual fuels. But, an engine should and must burn such commercial fuels as are available at bunkering depots throughout the world. Furthermore, any commercial engine should burn any of these grades without adjustments, however minor they may be in the opinion of the engine builder. Considering for a moment the oil-fired steamer, we find that the only criterion is the viscosity of the fuel oil, which has nothing whatever to do with the burning of the oil but with the facilities for handling the oil on board the vessel. As regards the oil burning equipment proper, we find that a slight adjustment of the oil temperature and oil burner pressure suffices to produce that degree of complete combustion which is necessary to maintain the required rate of evaporation of the boilers. The adjustments of an oil engine, therefore, must be reduced to a smiilar degree if satisfactory results under sea-going conditions are to be maintained.

On the 1,000 shaft b.h.p. engine, Anglo-Mexican fuel-oil of standard grade was used during the seven days' trial. No alterations or adjustments were made to the engine for this trial, the specific object being to find out whether the engine could economically use this class of fuel with average fuel settings which would be suitable for a large range of oils. There is no doubt that by using suitable valve settings and making other slight modifications slightly better results than those obtained would have become possible. If, therefore, an engine of this type were to be bunkering regularly such a fuel the engine could be slightly adjusted accordingly with a resultant reduction in the fuel consumption.

No alterations were made to the fuel-oil pipes on the engine or test bed arrangements. The oil was simply heated in the daily service-tank by a steam coil usually fitted and this arrangement worked quite satisfactorily although in a vessel using such heavy grade fuel it is to be recommended that a light oil tank should be fitted to clear the heavy oil out of the pipes before stopping and to ensure a positive starting-up after the engine has been shut down for some time.

In Table No. III the average results of this trial for the week are compiled and the specification of the Anglo-Mexican fuel oil is appended.



Indicator-cards referred to in this article

TABLE No. III.

ENGINE No. 2027—STARBOARD

Four Cylinders—Pistons 18½" diameter x 25" stroke.

7 Daks' Trial on Anglo Mexican Fuel Oil Stadard Grade.

R.P.M	120
S.H.P	1,000
Fuel Consumption, lbs. per S.H.P. /hour	0.42
Blast Pressure (lbs. per sq. inch)	950

SUMMARY OF DATA OBTAINED FROM THE INDICATOR DIAGRAMS.

	Test Number:—	1	4	5	6	7	9a	
	No. of Cyl.	POWER CYLINDERS—MEAN EFFECTIVE PRESSURES IN POUNDS PER SQUARE INCH.						
1.	1 T.	86.1	96.3	52.2	56.8	77.8	85.8	For power cylinders. I.H.P. = P_m R C where R is the revs. per minute and C = 0.1358
2.	1 B.	97.8 — 92.0	106.2 — 101.2	63.6 — 57.9	63.2 — 60.0	83.0 — 80.4	98.8 — 92.3	
3.	2 T.	86.5	106.0	50.7	65.5	74.8	84.5	
4.	2 B.	103.9 — 95.2	118.0 — 109.0	72.5 — 61.6	80.0 — 72.7	93.0 — 83.9	107.0 — 95.7	
5.	3 T.	68.9	79.5	50.2	54.0	66.8	80.3	
6.	3 B.	87.4 — 78.1	100.8 — 92.1	70.3 — 61.6	67.5 — 60.7	85.5 — 76.1	94.7 — 87.5	
7.	4 T.	83.5	98.8	57.7	68.0	75.3	86.3	
8.	4 B.	97.9 — 90.7	116.0 — 107.4	68.5 — 63.1	78.5 — 73.2	96.0 — 85.6	105.6 — 95.9	
9.	M.E.P. for all pistons	89.0	102.4	59.5	66.6	81.5	92.8	
10.	Revolutions per minute	117.3	118.3	58.5	90.5	110.6	121.1	
11.	I.H.P. Total	1420	1648	473	818	1220	1526	
		SCAVENGE CYLINDERS—MEAN EFFECTIVE PRESSURE IN POUNDS PER SQUARE INCH.						
12.	1	3.14	2.16	0.78	....	2.56	2.56	
13.	2	2.34	2.44	0.41	....	1.90	3.47	
14.	3	3.00	3.14	0.83	....	2.46	3.24	For scavenge cylinders. I.H.P. = P_m R C where C = 0.2326.
15.	4	2.95	3.15	0.86	....	2.32	3.18	
16.	M.E.P. for all pistons	2.86	3.00	0.72	....	2.31	3.11	
17.	I.H.P. Total	78.2	82.5	9.8	....	59.5	87.6	
		PRESSURE OF AIR IN AIR BELTS OF POWER CYLINDERS IN POUNDS PER SQUARE INCH.						
18.		1.65	1.86	0.5	0.99	1.47	1.91	
		AIR COMPRESSOR—MEAN EFFECTIVE PRESSURES IN POUNDS PER SQUARE INCH.						
19.	1st stage	14.2	12.8	19.9	12.8	11.3	12.8	I.H.P. = 0.0169 P_m R
20.	2nd stage	71.1	70.8	87.2	75.5	59.8	83.3	I.H.P. = 0.00375 P_m R
21.	3rd stage	350.4	344.0	279.0	273.8	295.0	358.5	I.H.P. = 0.000764 P_m R
22.	I.H.P. 1st stage	28.2	25.6	19.7	19.6	21.1	26.2	
23.	I.H.P. 2nd stage	31.3	31.4	19.1	22.2	24.8	37.8	
24.	I.H.P. 3rd stage	31.4	31.1	12.5	18.9	24.9	33.2	
25.	I.H.P. Total	90.9	88.1	51.3	60.7	70.8	97.2	
26.	Power Cylinder I.H.P. less compressor I.H.P	1329	1560	422	757	1149	1429	
27.	Net I.H.P. of engine, i.e., I.H.P. of power cylinders less the I.H.P. expended in scavenge cylinders and compressor	1251	1477	412	....	1090	1341	

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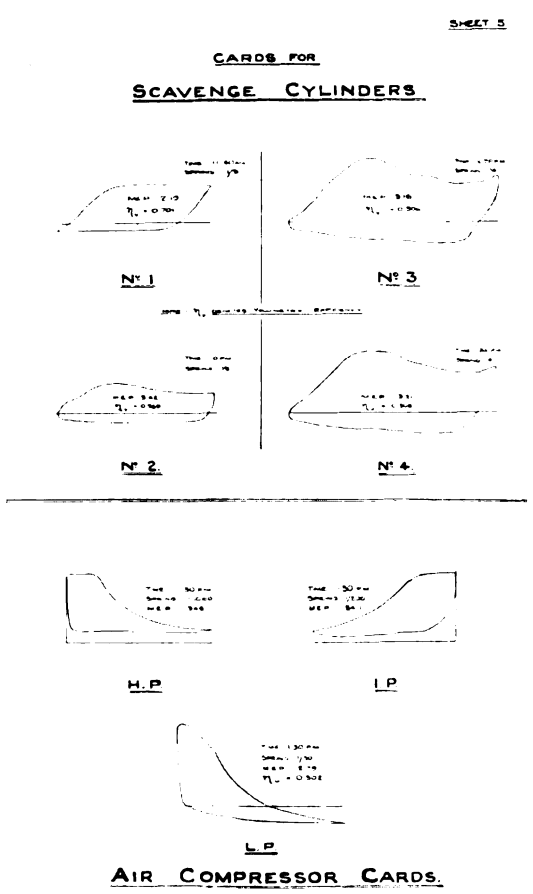


Sheet 5.—Typical cards referred to by the author

Scavenge Air Pressure (lbs. per sq. inch)	1.9
Lubricating Oil Pressure (lbs. per sq. inch)	12.7
Circulating Water Pressure (lbs. per sq. inch)	13.5
Exhaust Temperature	466°F.
Oil Specification.	
Specific Gravity @ 66°F	0.948 (17.75 Baume)
Flash Point	162°F.
Ignition Point	238°F.
Calorific Value, Gross	18,860 B.Th.U's. per lb.
Coke	9.5%
Sulphur	2.93%
Ash	0.06%
Water	Trace

On completion of this trial the engine was opened up and found to be in very good condition, all the piston-rings being free in their grooves and the running surfaces exceedingly clean and free from that tarry deposit which is found with engines not properly adjusted for burning heavy residual fuels. As was to be expected, there was the usual slight carbonization from the lubricating oil but careful examination failed to reveal any deposits from the fuel oil. The ports were very clean for the period the engine had been under test and there is no reason why this type of engine should not satisfactorily operate on similar fuels for normal periods at sea without being dismantled for cleaning purposes. The following is the report on the text made by Professor W. H. Watkinson.

Professor W. H. Watkinson's Report

The engine tested consists of two units combined on one crankshaft, and each unit of two power cylinders with four power pistons and two scavenge pumps. The distinguishing feature of the engine is that the power pistons are connected by crossed rods which enable the number of cranks per unit to be reduced to two, thus shortening and simplifying the engine, as compared with other opposed piston engines and enabling it to run much more steadily owing to the consequent great reduction of the unbalanced inertia forces. The cranks of each unit are inclined to each other at 180°, and the cranks of one unit are inclined to the cranks of the other unit at 90°.

The power pistons are 18½ inches in diameter and their stroke is 25 inches. The scavenge pistons have an area of 921 square inches and a stroke of 25 inches. All the auxiliaries, including the air compressor, the scavenge pumps and the circulating pumps are driven by the engine.

The first series of tests were made during a continuous run of 26½ hours on the 20th and 21st of March, 1922, and the second tests were made during a run of 8 hours on the 31st of March. The arrangements made prior to the tests for obtaining all possible data regarding the operation of the engine were more complete than have ever been previously attempted in connection with an oil engine of so great a power as this, and, in spite of some difficulties, these arrangements proved satisfactory. In addition to the measurements usually made for testing an engine of this power, measurements were made of the rates of flow of the following: (1) the cooling water through the jackets of the power cylinders; (2) the cooling water through the jackets, intercoolers, and after cooler of the air compressor; (3) the water through the oil cooler; (4) the cooling oil for the power pistons; (5) the lubricating oil for the bearings; (6) the air to the scavenge pumps. In all these cases the circular orifice method, with tanks and stilling arrangements, was adopted. For the measurements of the pressure difference on the two sides of the air measuring orifice a water column gauge was used, and for the measurement of the pressure of the air in the scavenge belt a mercury column gauge was used.

Each set of indicator diagrams consist of 15 cards and all these were taken as nearly as possible at the same instant, but it was, of course, impossible to take the diagrams for the top and bottom pistons at the same time. All the indicators and thermometers used during the tests were tested in my laboratory at the University and the readings taken during the tests of the engine were corrected, where necessary, in accordance with the calibrations of the instruments.

The fuel oil was weighed continuously on two weighing machines and I tested the machines by means of standard weights and found that they were correct.

Samples of the fuel oil were taken during the tests, and these were afterwards tested in a bomb calorimeter and in other ways, with the following results:

	Oil Used in Tests	
	Nos. 1 to 8	Nos. 9 and 9a
Calorific Value (lower) B.T.U.	18090	18260
Specific Gravity at 59°F.	0.878	0.880
Flash Point	181°F.	185°F.
Viscosity at 62°F.	55 seconds	61 seconds

The calorific value of the sample taken for tests 9 and 9a was 0.9% greater than that of the samples collected for the other tests, and it had a slightly higher density, flash point and viscosity.

I have calculated the value of n in the equation $PV^n=C$ from cards taken from the power cylinders during test No. 9 with the following results, which are the means for four cards taken from each cylinder:

No. of Cylinder	Value of n	
	Compression	Expansion
1	1.396	1.167
2	1.371	1.207
3	1.344	1.185
4	1.378	1.244

I have divided the test made on March 31st into two, No. 9 and No. 9a, because the engine did not give as good results during the first four hours as it did during the last three hours. I was informed at the time that this was probably due to boiler oil having been used in the engine on the previous day.

The accompanying sheets contain the means of all the readings taken during the tests and the results derived from these data.

The results given on sheet 3 show that the power developed in cylinder No. 3 was consistently lower than that developed in the other cylinders.

We obtain for test 9a the following results, the percentage being based on the heat due to to the fuel oil used per minute:

Heat due to oil used per minute—145,800 B.t.u.

	B.T.U.	%
Heat equivalent of indicated work per min	67430	44.4
Heat carried away by jacket water per min	30630	21.0
Heat carried away by piston cooling oil per min	5230	3.6
Heat carried away to exhaust	36200	24.8
Heat lost by radiation, etc. (by diff.)	9010	6.2
	145,800	100.0

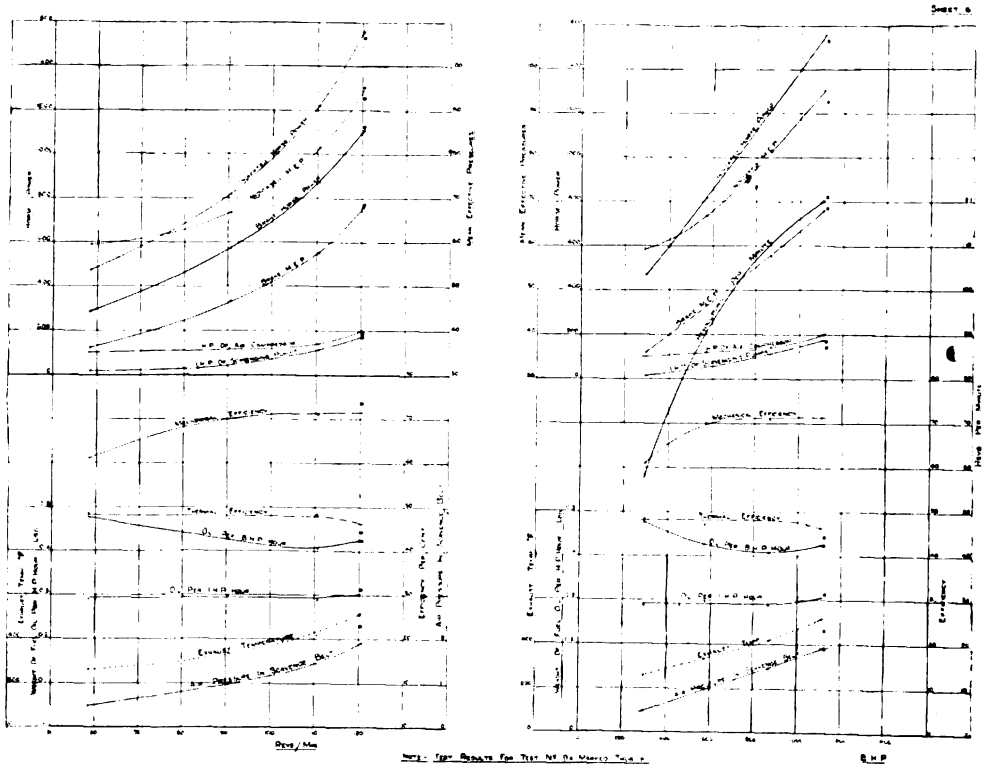
From this we see that the brake thermal efficiency is 32.7%.

The distribution of the heat in the engine is shown graphically in two ways on sheet 7.

A set of indicator diagrams is given.

Various curves giving the results of the tests made in accordance with the propeller law are given on sheet No. 6, and on the same sheet the results are given on a brake horse-power base.

(To be continued)



Sheet 6.—Test-curves for the Cammellaird-Fullagar Diesel-engine

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Eight Years Service of a Converted Steamer

Successful Operation of the Single-Screw Motorship "Songdal." — Forty-six Per Cent. of the Total Fuel Has Been Consumed by the Donkey-Boiler

By ALBERT ELISHAK
Third Engineer of the "Songdal"

THAT the Wm. Cramp Ship & Engine Company of Philadelphia are now converting the single-screw Hog Island type ship "Seekonk" to Cramp B. & W. type Diesel power, that the New York Shipbuilding Corpn. are converting two big freighters to Werkspoor Diesel drive, that the Munson Line is converting two Lake type freighters to twin-screw McIntosh & Seymour Diesel power, and that many other shipbuilders are figuring upon taking advantage of the loan fund if passed by Congress and borrowing money at not less than two percent for the conversion of existing steamers to motor power, should greatly increase interest in the operation of the three single-screw sister motorships "Songdal," "Songvand" and "Songvar." These vessels, it may be remembered, were originally built in Scotland to the order of the East Asiatic Company under the names "Bandon," "Chumpon" and "Pangan" and eight years ago were converted to single-screw Burmeister & Wain Diesel power of British construction.

During the war they were purchased by the Norwegian Government who after making a total profit of about $2,000,000 on the three vessels, sold them to S. O. Stray & Co., of New York and Christiania at a cost of $240 per d.w. ton. Despite the high purchase price of these vessels, the present owners have been able to keep them in almost constant service, although the "Songdal" was laid-up for two months during the most critical period for shipping that Norway ever experienced. Their names when owned by Norway were the "Folkvard," "Landvard" and "Lidvard."

A very complete article on the operation of the "Songvand" was published in the February, 1921, issue of MOTORSHIP, which gives accurate information regarding the history, dimensions, accommodations and engine-room arrangements of this vessel. In fact, the dates, tables and illustrations accompanied the article would also apply to the "Songdal" with minor alterations.

Name of ship	M.S. "Songdal," ex-M.S. "Folkvard," ex-S.S. "Bandon"
Name of owner	S. O. Stray & Co., Christiania and New York
Name of builder of hull	Barclay, Curle & Co., Ltd., Glasgow (1909)
Name of engine builder	Burmeister & Wain (Diesel system), Ltd., Glasgow (Now Harland & Wolff's Diesel Dept.)
Date of conversion from steamer	1914
Class and society	1A1 Norske Veritas
Displacement (loaded)	7,730 tons
Displacement (light)	2,630 tons
Deadweight capacity	5,100 tons
Net cargo capacity (excluding fuel and water)	4,350 tons
Gross tonnage	3,466 tons
Under deck tonnage	3,145 tons
Net register tonnage	2,172 tons
Length (B.P.)	330'0"
Breadth (moulded)	47'0"
Depth (moulded)	28'0"
Loaded draught	21'3"
Capacity of fuel bunkers. Double bottom and 2 deep tanks	640 tons
Total fresh-water carried	42 tons
Indicated H.P.	1,600 H.P.
Engine-speed	110 R.P.M.
Propeller	12' dia. by 10 ft. pitch (8% slip)
Daily fuel-oil consumption (including donkey-boiler,	8.1 tons (at sea)
Daily fuel-consumption in port	2.8 tons (when 2 boilers) 1.5 tons (when 1 boiler)
Daily lubricating-oil consumption	138 kg.
No. of engine staff	10
Type of Diesel engine	4-cycle, single-acting, direct-reversible, 6-cylinder single-screw
Bore of cylinder	670 m/m (26.38")
Piston stroke	1000 m/m (39.38")
Type of deck machinery	steam-driven
Area of heating surface	2 boilers, 50m² (540 sq. ft.)
Consumption of donkey-boiler	1½ tons fresh water at sea

The writer is 3rd Engineer of the motorship "Songdal," having joined this ship in June, 1921. After the short period of laying-up referred to, this vessel left Stavanger on June 26 for New York, in ballast, when she started in regular service between North and South America on the east coast followed by her two sister motorships "Songvond" and "Songvar."

At the time of commencing this article—which I am especially writing for MOTORSHIP, we are on the second return trip from Montevideo to Boston, Mass. It is anticipated that this route will be continued indefinitely by these three vessels. Because the previous article referred to gave a complete description of the "Songvond" and her voyages, I will content myself with referring to the machinery and including my personal experiences. However, for the benefit of those who were not readers of MOTORSHIP when the previous article was published, I give a new table of dimensions which will also include some minor corrections.

The main Diesel engine of this ship was constructed in Scotland in 1913, and has since been in almost constant operation. It is not only one of the oldest Diesel engines in the merchant-ship field, but also is one of the first type of its particular dimensions. Consequently it has a number of features of design which have been eliminated or changed in later constructions.

Nevertheless, all the time that I have been on board, the engine has worked satisfactorily. It would be easy to devote space to describing in detail any one or all of the non-stop trips during the last ten months and discuss it with enthusiasm, but I consider it more useful to give an average of the entire period. On such voyages that engine stops were necessary, we found after proper calculation that the delay was not even 2 per cent of the time at sea, the causes were as follows:

Main Engine	40%
*Operation during strike period	35%
Donkey Boiler and Auxiliary	25%

To a certain extent the operation of the motor depended upon some of the auxiliaries such as the lubricating and cooling-water pumps, which were steam-driven from the donkey-boiler. Over 25% of the stops were due to this feature. I later will discuss this in more detail. As the operation and design of the Burmeister & Wain type Diesel engine are well known to readers of MOTORSHIP, there is no necessity for the writer to go into details, but a few words regarding the general arrangement may be advisable. The main engine has six cylinders of the single-acting four-cycle type, these cylinders being divided into two groups of three, with the train-of-wheels drive for the camshaft in the center.

The crankcase is practically enclosed while the air-compressor is directly driven-off the extension on the front end of the crankshaft. It delivers under normal circumstances all the necessary injection-air at 852 lbs. per square inch, as well as a controlled surplus for the starting-air storage tanks at 426 pounds. Any over-supply is arranged to pass out through the ship's deck with a view to improving the ventilation in the engine-room by forming a draught.

There is a three-stage auxiliary air-compressor driven by a twin cylinder B. & W. four-cycle Diesel engine. This delivers air to the storage tanks for starting and fuel-injection in case the same is needed after a lengthy stop. Also, it can be used as a maneuvring compressor at times when a large number of reverses are required. Also, in the case of break-down in the main compressor on the engine this set can furnish all the air required by the main engine.

For operating this little auxiliary Diesel engine it has its own direct-driven two-stage air-compressor which supplies separate air bottles for injection or starting at 852 lbs. Then again, should the supply in these bottles run out, and the auxiliary engine be stopped as well as the main engine, there is for final reserve a two-stage emergency compressor driven by belt drive from the steam dynamo set. All other auxiliaries are driven by steam of 100 lbs. pressure from two oil-fired donkey-boilers, of which one is a spare, only one being used at sea. The latter has a heating surface of about 50 meters.

It generally takes about eight hours to get up steam. The steam-driven auxiliaries are as follows——

In Engine Room

1 centrifugal-water circulating pump (cooling water to crosshead-guides, cylinder-jackets, covers, compressor and its intercoolers, thrust-blocks, lubricating-oil-coolers, condensers).
1 rotary pump for lubricating-and-piston-cooling oil. These two pumps directly coupled to a high-speed steam-engine.
1 ballast pump (also reserve cooling-water and bilge pump), duplex type.
1 bilge pump (duplex).
1 deckwash and sanitary pump (duplex). Also condenser-circulating pump in port.
2 spare lubricating-oil pumps (duplex).
1 engine fuel-oil service-pump (duplex).
1 boiler-feed-pump (duplex).
1 spare boiler-feed pump (duplex). (Also bilge and sanitary pump.)
1 15-H.P. high-speed engine direct coupled to a 11 K.W. electric-generator and with 2 belt-drives (a) to a transmission for the machine-tools (b) for the small emergency air-compressor.
1 evaporator, which gets pre-heated water from the cooling water spaces around the exhaust silencer.
2 small Korting-Duplex fuel-oil pumps for the boilers and an oil pre-heating arrangement.
1 steering-gear.

On Deck.

10 winches for 5-ton derricks.
1 anchor windlass.
1 steam whistle.
1 steam siren.
Steam heating arrangements for all the accommodations.

We will now deal with the fuel-oil consumption. This *at sea* is about 8.1 tons per 24 hours. Of this 68 per cent is used by the Diesel engines and 32 per cent by *one* donkey-boiler. The same oil is used as fuel for both motor and boilers. The oil generally used contains a slightly higher percentage of sulphur than is considered advisable for Diesel engines of this nature. I merely give this as a general statement about this oil, because I have made no analysis.

The consumption of the main Diesel engine was 143 gr (0.31 lb.) when developing the normal load of 1,600 i.h.p. at 100 r.p.m., which is about the same as most four-cycle Diesel engines when operating on an average grade of fuel-oil.

I must draw particular attention to the fact that I am unable to give the accurate calorific value of fuels that were used. The proportion figures of 68 per cent and 32 per cent just mentioned, show what influences steam-driven auxiliaries have on motorships on the total

*During the strike of marine engineers in Norway it was impossible to secure all experienced engineers. Consequently the ship had to be operated with such men as were available. Therefore complete reliability could not be expected during that particular period.

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fuel-consumption, and so detract from the economy of the Diesel engine. The auxiliaries only require from 50 to 60 h.p. on an average, compared with 1,600 I.H.P. for the main engine. Yet, the auxiliaries burn almost half the quantity of fuel used for propulsion.

When in port and operating all ten winches for eight hours per day, the dynamo and circulating pump per 15 hours, the fuel-consumption is 2.8 tons which includes heating the boilers every morning. This consumption includes two boilers, one for 17 hours and the other for 12 hours. Occasionally one boiler is sufficient, such as when all the winches are not in use and then the consumption is about 1½ tons. But, if we take the consumption for an entire voyage and include both sea and port consumptions the results will be 54 per cent. of the fuel for the main engine and 46 per cent. for the boilers, because the time at sea nearly approximates the time at port.

Next we will take the question of lubricating-oil consumption at sea, which amounts to 138 kg. per 24 hours or 3.6 gr. per h. p. hour. This figure is an average for the voyage between Norway, U. S. A., River Plate ports and back to the U. S. A., and may be considered higher than the average consumption because the temperature of the cooling water varied between 3° and 29° C., and thus influences the viscosity of the lubricating-oil and the leakage.

Following are the lubricating-oil arrangements and consumption:

Circulating lubricating oil.....119 kg./24 hours
(Lubrication of main bearings, connecting-rod bearings and crosshead-guides and piston-cooling of the main engine; lubrication of the crank drive of the steam engines for cooling-water and lubricating-oil pumps).
Cylinder oil .....9 kg.
Compressor .....2 kg.
Lubricating oil for lubrication by hand (camshaft, etc.) ..... 8 kg.

It is obvious that the greatest consumption is made by the circulating oil. This is carried in a compartment of the engine room bottom tank and is pumped through coolers and strainers through the engine bearings, whence it is fed by gravity back to the tanks. It may be assumed that one reason for the high consumption is that too much oil is thrown up against the cylinder walls and taken by the pistons into the combustion chamber and burned. But, as the exhaust-gases are always free from smoke, indications are that this is not the case.

Furthermore, if the oil has been gasified by the heat of the pistons, there should be some tangible indication outside. Consequently, the high consumption must be due to leakage. The chief leakage is in the packing-box where the main shaft projects from the crankcase, and in the packing-box of the auxiliary steam engine that drives the cooling water and lubricating oil-pumps. We have been able to collect oil that is wasted by these parts. But, in other places, such as in the center section of the crankcase or in the large packing-box of the duplex spare lubricating-oil pumps, it was impossible to collect the oil that leaked.

In the paragraphs that follow I will give some information regarding the working of the main engine, the auxiliary compressors and other auxiliaries, as well as occasionally deal with the influences of the various consumptions, speed, etc. All parts of the crank drive, *i. e.*, the crankshaft, main bearings connecting-rods and other bearings, and crossheads have all worked satisfactorily. They are all in the enclosed crankcase and have forced lubrication. The same oil is also used for cooling the pistons of the main engine and consequently becomes fairly warm. Naturally, the oil is re-cooled after using, by passing through sea-water cooling devices. But in tropical water the cooling is not very efficient. In fact, we have measured temperatures in the crankcase up to 56 degs. C. (132.8F). At this temperature it is not possible to keep one's hand on the doors on the rear side of the crankcase. The main bearings are not water-cooled.

All moving parts, such as the main bearings, connecting-rod bearings, cross-heads and pistons, were examined and adjusted before leaving Norway on our last trip. After another year's operation the next examination will take place when in New York.

After every long voyage only the normal wear the piston-pin bushes of the connecting-rod are adjusted; the clearance when necessary is adjusted to normal by removing and replacing of liners. In a like manner the camshaft drive, as well as the camshaft rollers, links, rods and rocking levers operate properly in all details. The thrust-block and shaft bearings in the tunnel remain "hand-warm" up to 108-109 revolutions per minute when in tropical waters. Even at higher engine speed additional lubrication has proved sufficient to eliminate any danger.

One of the blades of the propeller of this ship is bent about 6" through having been damaged when passing through ice. Consequently, the pitch has decreased. It is due to the effect of this damage that the "Songdal" is making less speed than her sister motorships. Also, the unequal moments of resistance have had bad influences on the tightness in the sternbox, as well as on the stability of the two last shaft bearings.

As regards the pistons of the main engines, neither they or their oil-cooling system have ever given any trouble.

Next we will refer to the crankcase cylinders and cylinder-heads. Heavy crankcase castings enclose the crank and cross-head space, and there is a division between every pair of cylinders, tied together by fitted bolts. Separately cast cylinder-jackets are placed directly on these columns, as well as the liners being fitted into jackets with packing on both the top and lower joints, but open against the crankcase. This particular engine has not the three-cylinder en-bloc arrangement which has been incorporated into more recent Burmeister & Wain Diesel engines.

Although the cylinder beams do not give fully adequate stiffness to the entire construction, I have only noticed a very small breathing of the columns and the tightness on the lashes. This may be called very good—after eight years operation! Only at the center lash between the third and fourth cylinder where the greatest stresses come, and where the wear of the bolts is shown, was there a leakage of oil. When leakages were found at other points, for instance on the large doors at the rear of the engine the said leakages were not of any great importance and only slightly dirtied the engine.

The fit of the cylinder liners in the jackets has nearly always been satisfactory. Once there was a leakage of cooling-water along the copper joint between the cylinder and liner, but we put an asbestos band above the coppering and tightened the cylinder-head bolts. This was satisfactory.

The load and speed of the engine have considerable influence on the cylinder-heads, and in my opinion a continuous overloading beyond the rated power of the engine is not good for the heads. It is believed by some engineers that no form of construction will prevent cracks on the under side of the cylinder-head in the space between the exhaust and fuel-valves with engines of the four-cycle principle, in which the maneuvring is carried out by compressed-air directly in the working cylinders. But in some designs of Diesel engine cylinder-heads the injection-valve is offset from the center, giving more cooling space between the exhaust and injection valves.

When maneuvring in some ports such as Buenos Aires, we have had as many as 30 to 40 maneuvers of the engine in about 1½ hours, occasionally two reverses in a minute. This results in many variations of temperature and frequent cooling of the cylinder-head following being in a continuously warm condition after a long voyage. This cooling is caused by the cold starting-air and must contribute its share to the formation of cracks or hair-cracks.

Seeing that donkey-boilers in this ship consume such a large proportion of the fuel, it is easy to understand why the owners prefer to purchase the cheap oil and not the regular Diesel-oil at higher cost.

Here I must point out that every crack did not mean a useless cylinder-head, provided the cracks did not become enlarged to the extent of allowing cooling-water to pass into the combustion-chamber or gases into the cooling water space in the head. Unless this occurs, there is no danger of any reduced power. Generally, months or years pass without any cracks. Even when cracks arise it is possible by careful attendance to lengthen the time of useful service of the heads; although cracks sometimes leak through the heads, becoming cold during the maneuvring periods. When the engine is continually running and the heads are warm, the cracks keep tight.

Consequently, after the first signal of the engine-room telegraph we stopped the cooling-water circulation, opened the handholes and drained the cooling space in the head. In this manner the head does not become cool when maneuvring. Once we tried to rust a crack together by using a solution of salammoniac in the cylinder-head where it leaked through the crack, but the result was only of short duration. This is not surprising considering the large diameter of the cylinders.

Many questions are asked by shipowners investigating the Diesel engine question, as to how often valves have to be ground. With this engine the fuel-valves were reground on an average of every two months or after each 800 hours of running. Change of valve was never made because of leakage in the valve-seat, but only because of leakage in the packing-box. The packing material is a flaky mixture of asbestos and graphite and is pressed in lightly in layers.

On another Swedish motorship, which had twin 1,100 B. & W. Diesel engines, I discovered that after packing the spindles are ground-in the packing by continually moving with a slight in-and-out motion by hand for two to three hours, after which the valves operate satisfactorily for twelve to fifteen months continuous service. As this method requires great exertion of force, even with the smaller valve spindles of 1,100 h.p. engine, we did not desire to adopt this with our larger ones of 1,600 h.p.

(*To be continued in the next issue*)

TWO STEAMERS TO BE CONVERTED BY NEW YORK SHIPBUILDING CORP.

In our September issue we published the first announcement that the New York Shipbldg. Corp. had purchased the Shipping Board steamer "Ashbee" and would instal her with a 2,000 i.h.p. New York-Werkspoor Diesel engine now nearing completion at Camden. The first illustration to be published of this engine was also given. We are now able to announce that they will instal a duplicate of this 2,000 i.h.p. Diesel engine in the sister steamer "Jacksonville" which they have also purchased from the Shipping Board.

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MOTOR STERN-WHEEL RIVER BOATS FOR EGYPTIAN GOVERNMENT

RIVERS usually cross countries in such a way that they form a very serviceable means of transportation from the whole country to the sea, due to the tributaries in the form of shallow streams which flow into the main streams. We have not yet begun in this country to realize the enormous possibilities for development of our means of transportation on inland waterways, at least not in the case of small, shallow streams which usually traverse a section rich in some form of product, either agricultural or mineral. For work on such shallow rivers craft drawing but little water are needed and there are three methods of propulsion utilized in order to produce a boat that will operate with the requisite light draft, *i. e.*, tunnel stern, surface-propellers and paddle wheels.

On our own rivers and shallow bays the latter type of propulsion is most generally used, but mostly in the form of steam propelled stern-wheel craft. In view of the increased weight of a steam plant over that of an oil-engine installation certain cargo-carrying capacity is lost as well as the fuel which is wasted in the steam plant. This is unnecessary; many American firms have developed such shoal-draft craft with oil-engines and many have been built abroad which should afford sufficient reason to abandon the use of an obsolete craft. There is no section of the country now where oil fuel cannot be obtained to propel such craft. An example of what is being done by other countries in the line of oil-engined river craft should interest our readers.

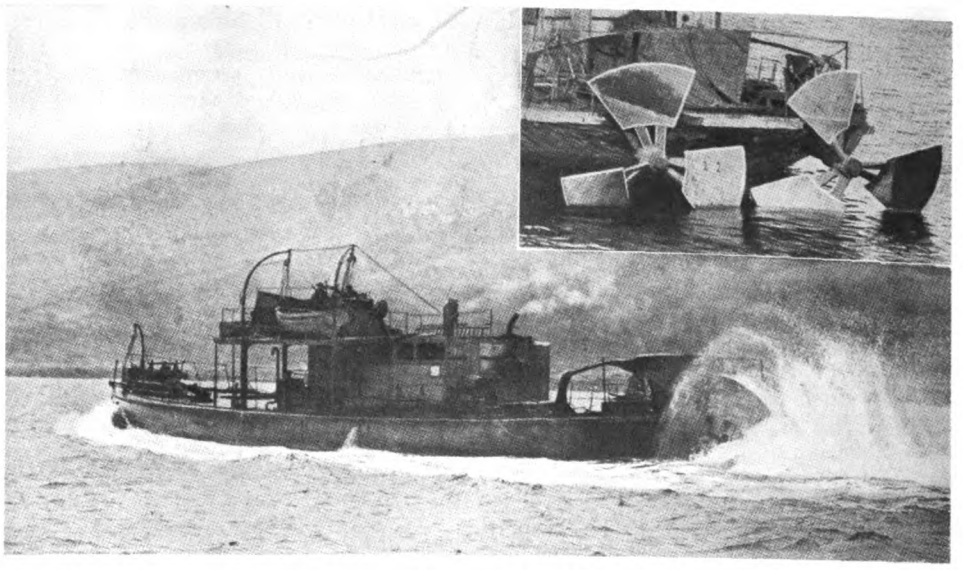
For some years we have wondered why the Egyptian Government has been a regular subscriber to MOTORSHIP. Now we understand! The Egyptian Government recently ordered some stern-wheel motorcraft for service on the Nile, having the following particulars:—

Length overall	60 ft.
Breadth	16 ft.
Draft	4 ft.
Horsepower	50
Engine revolutions	300 r.p.m.
Paddle revolutions	25 r.p.m.
Construction	steel

These craft were built by the Rennie, Ritchie and Newport Shipbuilding Co. of Wivenhoe, England, and powered with a 50 h.p. single-cylinder Plenty surface-ignition oil-engine running at 300 r.p.m., driving through a flexible coupling and 6 to 1 worm reduction-gear, which by means of chain drive reduced 2 to 1 operates the paddle wheels at 25 r.p.m., the total reduction being in the ratio of 12 to 1.

The chief problems in connection with stern-paddle propulsion are provision against breaking driving-chains or gear if the clutch is put in too rapidly on account of the inertia of the paddle-wheel and guarding against breaking driving-gear in case the boat suddenly runs on a bank. These problems are met by providing a slipping-device introduced in the chain-drive to enable the engine to take up the load gradually. This device consists of a chain-wheel having two cone-surfaces, one of which engages the block keyed to the paddle-shaft and the other with a sliding-cone which is held to its work by bolts and springs. The method of operation is to adjust all bolts holding the sliding-cone until the device will just transmit the full 50 h.p., but will slip with any increase in power. Therefore, if reversal without decreasing engine-speed takes place the device will slip and relieve the strain, the load being taken up gradually.

In view of service in a hot climate special care is taken to cool the worm reduction-gear by enclosing the same and by discharging a jet of oil into the entering-tooth of the worm, also by fitting cooling pipes and a circulating-pump for oil-circulation.



The Denny experimental vane-wheel propelled motorvessel. An oil-engine is fitted

NOVEL PROPULSION SYSTEM FOR OIL-ENGINED SHOAL-DRAFT BOATS

WILLIAM Denny & Bros., the well-known Dumbarton firm of shipbuilders quite experienced in the construction of shallow-draft boats, have evolved a system of vane-wheel propulsion which they claim as the most efficient which can be employed. While our readers will be reminded of the surface-propeller system invented and brought to a high state of development by Albert Hickman with his VIPER and SEA SLED, yet in place of Hickman's regular screw propellers Denny employs vane-wheels.

Exhaustive tank experiments were followed by the equipment of an experimental vessel fitted with an oil-engine coupled in a temporary manner by belt drive to two vane-wheels. Our illustration shows this experimental boat undergoing tests and the insert clearly shows the vane-wheels. The principal particulars of this boat are:—

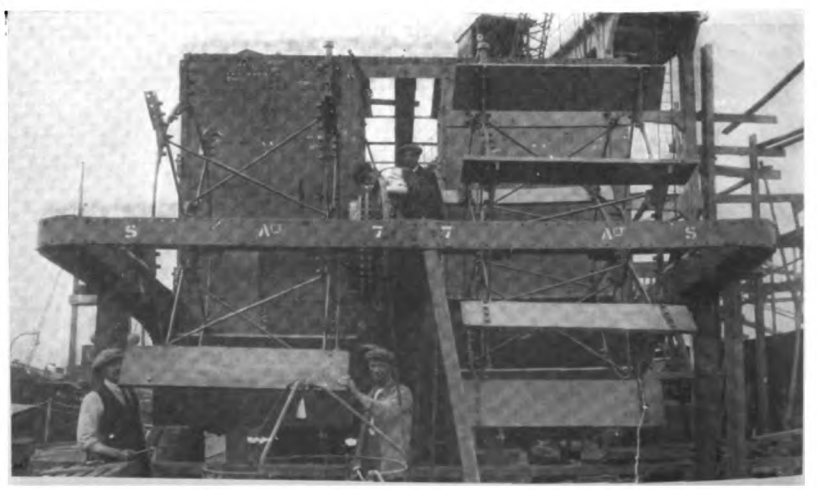
Length	100′ 0″
Breadth	23′ 6″
Draft	4′ 8″
Displacement	186 tons
Speed	9 knots
Horsepower (effective)	77.5

Messrs. Denny believe that the results of the trials of this boat prove that this system is superior to shoal-draft propulsion systems using propellers operating in tunnels or side or stern-paddles, but for rough water use the suitability of vane-wheels must yet be determined. This boat was first tested with her regular twin-screw propellers and then with vane-wheels, the results being as set forth in the following table:

	Screw Propellers	Vane-Wheels
Diameter	4′ 0″	11′ 0″
Pitch	5′ 8″	16′ 0″
No. of blades	3	3
Total disc. area	25.14 sq. ft.	....
Total projected area	10.2 sq. ft.	....
Immersion of tips in still water	3′ 07/16″	....
Revolutions per minute	226	66
Total sectional area of water acted upon at full speed..	...	59.26 sq. ft.
Effective horsepower	77.5	77.5
Shaft horsepower	197	116

It will be noted that these vane-wheels drove the boat at the same speed with 41 per cent less shaft h.p. than the usual propellers. The resistance of shaft, boss, brackets, etc., is eliminated; the vane-wheels rotate in opposite directions, outward at the top, the pitch of one wheel being right-handed, the other left. Maneuvring and reversing are all that can be desired and Messrs. Denny consider that this system has broad future use on vessels of both shoal and deep draft.

Oil-engined stern-wheeler building for the Egyptian government



Stern view showing one of the twin wheels

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New Motorship for the Svea Company

Launch of the "Frost," Third Diesel-Driven Vessel for Sweden's Largest Coastwise Transportation Firm

SEEING that the Stockholm Rederiaktiebolaget Svea owns 92 coastwise vessels, aggregating 105,220 tons deadweight, any movement that this firm makes naturally has important bearing upon coastwise transportation. Practically all their fleet are steamers, the largest being of 4,400 tons, which is not surprising because Sweden has no natural oil-supply, and so all oil-fuel used on coastal craft must have the importation charges added to its cost. Despite this drawback it is evident

Motorship "Frost" just after the launching

that the firm's experience with the two motorships GESTRIKLAND and FINN demonstrate that economies are effected, because they have also experimented with turbine-electric drive, owning the MJOLNER, which was the first ship equipped with a Ljungstrom turbine and electric transmission. Consequently, it is gratifying to note that this great company are giving tangible evidence of their recognition of the inherent advantages of motor power in coastwise service by ordering a third Diesel vessel, the FROST, launched on Aug. 17th, which will somewhat shatter the theory held in some quarters that the motorship is only economical on long distance voyages because of its higher first cost.

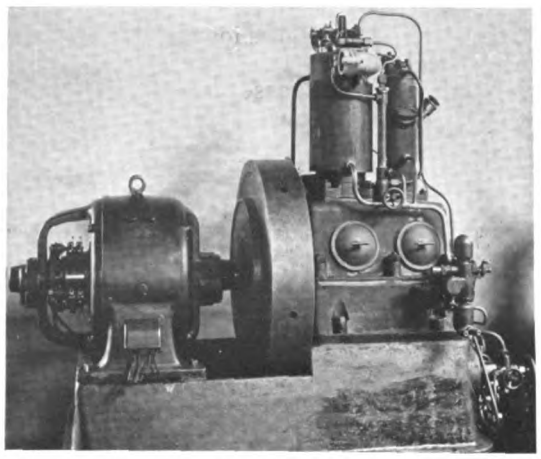
The FROST is a sister-ship to the FINN, placed in service in December, 1920, but incorporates some modifications. She is a shelter-deck boat, classed with the Bureau Veritas. She was built, like the FINN, at the Aktiebolaget Finnboda Varf, Stockholm, from designs by D. A. Hector, director and chief-engineer of the yard.

She has the following dimensions:

Deadweight capacity	2,745 tons
Net Cargo Capacity	2,245 tons
Fuel-capacity	430 tons
Length O.A.	285'0"
Length B.P.	273'7½"
Breadth M.D.	41'0"
Depth to S.D.	25'6"
Draught	17'6"
Power (twin-screw)	1,000 shaft
Daily Fuel-consumption at sea	4½ tons
Engine and Propellor Speed	150 r.p.m.
Ship's speed	10½ knots

To propel the vessel there are two Atlas-Polar two-cycle, direct-reversible Diesel engines of 500 shaft h.p., each having four working cylinders 15.748" bore by 28.346" stroke, and in line with the main cylinders there are two double-acting scavenging and maneuvering cylinders, with a super-imposed air-compressor on one of them, which design is now well-known.

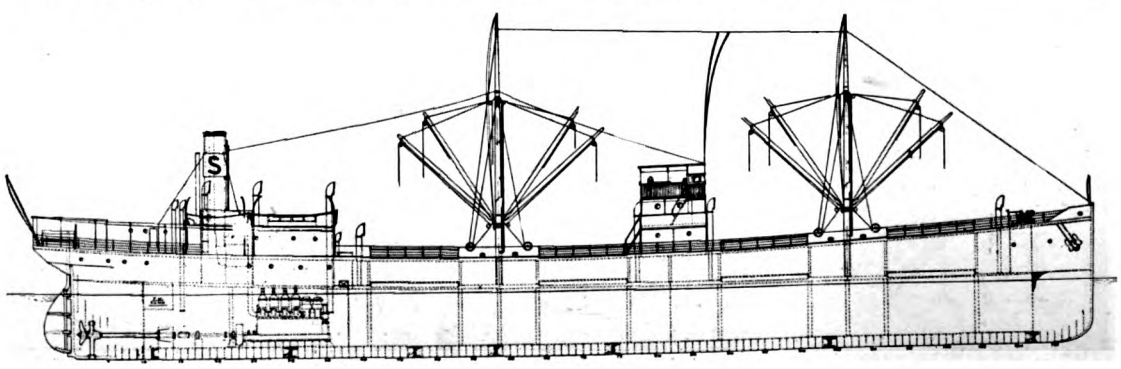
We are rather surprised to find that all the deck machinery is steam driven, so it was necessary to install two coal-burning donkey-boilers of 500 sq. ft. surface for use when in port to operate six four-ton winches and the eight steel derricks, etc. Thus in order to dispense with steam at sea, compressed air has to be used for auxiliaries that may require to be operated, for which there is a 25 b.h.p. Polar Diesel-engine coupled to a compressor and a 7½ b.h.p. eletcric-driven compressor, aside from a small hand-operated compressor. There also is a 12½ b.h.p. Polar Diesel driving a lighting generator, as well as a 10 b.h.p De Laval turbine generator set. For the fuel service there are two electric-driven pumps, one of 3 h.p. and the other of 1 h.p. The other pumps can be operated either by steam or by compressed air, as well as the steering-gear



The little Polar Diesel-driven electric generating set

and anchor-windlass. To secure the maximum efficiency when running equipment on air, the latter is pre-heated by passing the same through a coil in the exhaust silencer.

We fail to understand the economy of such an auxiliary arrangement, and as far as we can see a more economical and satisfactory arrangement would be to have all the engine-room and deck-machinery electrically driven, two auxiliary Diesels of about 75 b.h.p. supplying the necessary power. If the owners place sufficient confidence in oil-engine power to carry the vessel safely through all weathers, it is difficult to understand why such power can not be relied upon to operate the machinery when in port. Doubtless, the owners, or builders, have local reasons for the arrangement adopted that are not evident here, and, in the interests of shipbuilding development in general, possibly may be willing to state what the same are.



Plan of the new coastwise motorship "Frost"

PERFORMANCE OF AMERICAN MOTORSHIP "MISSOURIAN" ON MAIDEN VOYAGE

THERE are now two big Burmeister & Wain type motorships of similar name, the 8,200 tons CALIFORNIA, of the United Steamship Co. of Copenhagen, Denmark, and the CALIFORNIAN, operated by the United American Lines, so care should be exercised to avoid confusing the two craft. The Danish ship has been operating since 1913, whereas the American vessel has just completed her maiden voyage; her hull was built at the Merchants shipyard, and the Diesel engines at the Cramp plant. We dealt with the maiden trip of the CALIFORNIAN in our last issue.

The United American Line, however, is also operating the new sister motorship MISSOURIAN, which left New York on July 24th and made a non-stop run to Cristobal on the 30th, thence to Los Angeles harbor by August 10, San Francisco was made on August 15th, where she was due to leave, after discharging and loading, for European ports. The following are her runs:

Trip, New York to Panama Canal

Net time at sea	6 days, 14 hrs., 20 min.
Average speed	12.27 knots
Mean revolutions	112.29 R.P.M.
Mean indicated h.p.	3,360 approx.
Average daily fuel consumption	101¼ bbls. (14½ tons)
Hourly consumption per i.h.p (3 tests)	0.306 lb.
Draft arriving at Canal	22' 9½" mean

The fuel consumption per i.h.p. hour is really less than that as it included the oil used by two 75 b.h.p. auxiliary Diesels and by the galley range. This also applies to the second stage of the voyage.

Trip, Panama Canal to Los Angeles

Distance	2,917 naut. miles
Net time at sea	9 days, 17 hrs., 22 min.
Average speed	12.50 knots
Mean revolutions	113.89 R.P.M.
Mean indicated h.p.	4,410
Average daily fuel-consumption	
Hourly consumption per i.h.p.	0.310 lb.
Draft arriving at San Pedro	28' 8½" mean

It will be noticed that the engines gave better power on the second trip, although the revolutions were only increased very slightly. But the reduced draft and increased power gave the ship ¼ knot better average speed. There is no need for our comments on this splendid performance as the same almost "shouts for itself." The builders' trials only consisted of a 12 hours' run, as the owners were in a hurry for the vessel. The engines on this run on the Delaware River developed 4,479 i.h.p. at 115½ r.p.m., the ship displacing 6,579 tons.

After the trials the MISSOURIAN went to Boston and loaded 700 tons of cargo, then proceeded back to Philadelphia and took aboard 3,000 tons, and then went around to New York and finished loading. Her speed on these short runs averaged over 12¾ knots. The fuel used on the trial and maiden voyage was supplied by the Texas Co. and was of 0.913 gravity, 23.5 Baumé and contained 0.60 sulphur and 1.11 hard asphalt.

Like the CALIFORNIAN, the MISSOURIAN is a combined Cramp and Merchants product, while the deck machinery of the CALIFORNIAN was constructed by the American Engineering Co. and that of the MISSOURIAN by the Maine Electric Co. The first named has General Electric motors on deck, while the latter has Westinghouse make. Two winches on both ships, however, were built by the Shepard Co. and are of the new planetary design described some time ago in MOTORSHIP.

Captain R. P. Tapler is master of this fine vessel and Henry Timmer is chief-engineer.

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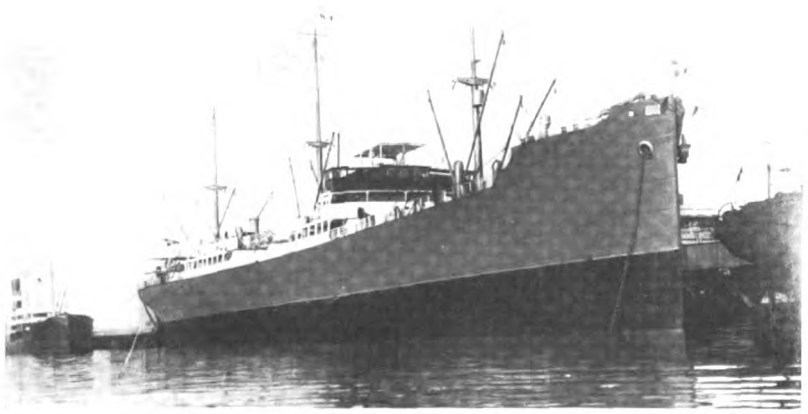
Further Performance of the Motorship "Handicap"

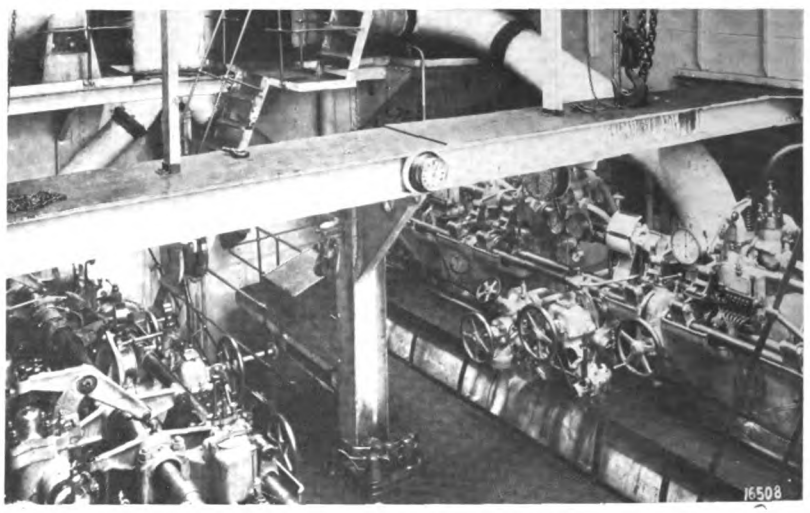
Her Cargo Capacity and Machinery Weight

IN our August issue, on page 619, a brief record was published of the maiden voyage of the Sulzer Diesel-engined Norwegian motorship HANDICAP. The reliability, and economy of this installation must have impressed all as further evidence that the modern two-cycle engine when well designed and built may be relied upon to produce results equally satisfactory as those of other types. Since this article was published further details have come to hand covering subsequent voyages of the HANDICAP which add to the credit due Sulzer Bros. for making possible such voyages.

We left her in our article at Hamburg, Germany after completing a voyage of 14,313 nautical miles without engine trouble and on a very low fuel-consumption. On April 23rd she sailed from Hamburg for Port Arthur, Texas, via Bilbao, Spain and Key West, Florida, a voyage of 5,450 nautical miles which she completed on May 14th. Here she loaded a cargo of kerosene packed in tin cans, for China, requiring from May 15th to June 2nd to load the 225,000 cases containing



The motorship "Handicap," propelled by twin Sulzer Diesel engines



Engine-room of the "Handicap"; note engine controls are all on the upper platform, a feature with all Sulzer driven vessels

two cans each, a total weight of 8,240 tons. Nearly all this cargo was loaded by the HANDICAP'S electric winches and during this loading period many representatives of American shipowners visited this ship and were greatly interested and pleased with the quiet and satisfactory operation of her electric-driven deck auxiliaries.

Power for the electric-auxiliaries is generated by Sulzer-engine driven generators and when this machinery is operating there is no outward indication of motion except the slight movement of the fuel-valves, and the engines make but a slightly perceptible noise. In fact, Captain Sandaa of the HANDICAP often pointed out to visitors the extreme quietness of operation of these engines, mentioning as well that in place of the 5 tons of coal a day which would be required for keeping-up steam for driving steam-winches on a coal-burning freighter of the size of the HANDICAP these Diesel-engines consume only a very small amount of oil.

In order to take advantage of the ship's large capacity, the largest amount of net cargo possible—8,240 tons—was loaded at Port Arthur, leaving 700 tons for fuel-oil to be loaded, the total deadweight being 8,940 tons. The HANDICAP left Port Arthur on June 2nd and arrived at Amoy (Hong Kong) on July 15th, after a run via the Panama Canal of 9,600 miles on which no stop was made and on which run only 410 tons of fuel were consumed, leaving 290 tons in the bunkers, sufficient for a further run of 7,250 miles.

Capt. Sandaa, who has commanded many steamships before becoming master of the HANDICAP, stated that steamers similar in size consumed 35 to 40 tons of coal per day as against an average daily consumption for five long voyages totalling about 30,000 miles on 9.4 to 9.7 tons daily of fuel-oil, depending upon the loaded condition of the ship. This figure includes the fuel consumed for all auxiliary machinery for lighting, cooking, heating, steering-gear, etc. and during the voyage the auxiliary engines developed an average of 159.5 brake h. p. distributed as follows: Turbo-blower 105 b. h. p.; Circulating water pump 10 b. h. p.; Lighting, cooking, heating, steering-gear, etc. 44.4 b. h. p. Worthy of note is the low scavenging-air pressure for the main-engines which is attained by the Sulzer turbo-blower scavenging system.

One of the advantages of the Diesel-driven ship is the added comfort afforded the engine-room crew, not only in their quarters, but in the engine-room as well. The excessive heat of the fire, boiler and engine-rooms of steamships is eliminated and even in tropical climates the temperature of the engine-room of the motorship is low enough to permit efficient work on the part of the engineers. It was noted on the voyage of the HANDICAP that when the temperature in the shade was 82 degrees F. (28 deg. C) and that of the sea-water was the same that the thermometer in the engine-room showed only 90 deg. F (32 deg. C) and the cooling-water left the engines at a temperature of 113 deg. F (45 deg C).

It is interesting to note that a coal-burning steamer having the same radius of action as the HANDICAP with 700 tons of fuel-oil would require to bunker at least 2,730 tons of coal, thus reducing the amount of cargo she could carry to 6,210 tons instead of the 8,240 tons carried by the HANDICAP. Or else she would have to bunker several times en route at varying prices. With freight-rates on shipments from the United States to China at $10 a ton this difference of 2,030 tons means $20,300 less earned by the steamer as compared to the HANDICAP or motorship of similar deadweight, apart from the big saving in the fuel bill. In actual fact, the steamer probably would bunker this total amount of coal at various ports en route, thus entailing the loss of four to five days, an expense for pilots, harbor dues, tugs, etc.; but an oil-fired steamer would carry 2,100 tons of oil-fuel in her double-bottoms and deep tank, so her cargo-capacity also would be heavily handicapped.

To tell the story in simple terms, the cubic capacity of the HANDICAP is considerably greater than that of a similar dimensioned steamship, being 488,850 cubic feet. She is 415 ft. long, 54′-6″ breadth and 36′-11″ depth. Much of this large cargo-space is due to the fact that the Sulzer engines are quite short for the power developed and the weight is likewise not excessive, being 342 tons including thrust-bearings, flywheels, turbo-blowers including electric-motors, silencers, starting and injection air-bottles. The auxiliary engines complete with flywheels, silencers, starting and injection air-bottles, but without dynamos, weigh 62 tons. Her twin Diesel engines develop 2,700 shaft horse-power.

"GINGER DOT"—ATTRACTIVE DIESEL YACHT

Late this summer Frank B. Stearns of Cleveland, Ohio, received delivery of a comfortable new cruiser from the Luders Marine Construction Co., of Stamford, Conn., in which two 60-80 h.p. Mianus oil-engines are installed. Our illustration shows the GINGER DOT to be quite the usual motor yacht in appearance and she has a good turn of speed as well, making 16 miles per hour. If GINGER DOT were powered with gasolene engines to make this speed, she would consume about 20 gallons of gasolene at about 25 cents per gallon, or about $5.00 worth of fuel per hour.

With the two Mianus oil-engines GINGER DOT consumes 72 cents worth of Diesel oil per hour. Needless to say, economy in such fast motor yachts is bound to bring about the general use of oil-engines in such craft.

DIESEL MOTOR YACHT "OHIO" LAUNCHED

On Sept. 16th there was launched at the yard of the Newport News Shipbuilding and Dry Dock Co., Newport News, Va., the second large steel Diesel motor yacht built by this firm from designs by Cox & Stevens of New York. This boat, the OHIO has the following dimensions:

Length	172 ft.
Breadth	26 ft.
Draft	11 ft. 6 in.

She will be propelled by two 350 h.p. six-cylinder Winton four-cycle Diesel-engines which will give the boat a speed of 12 knots and sufficient fuel will be carried to afford a cruising radius of 9,500 miles. The accommodations are remarkably comfortable. The OHIO was christened by Miss Isabell Ferguson, daughter of Homer L. Ferguson, president of the Newport News Shipbuilding & Dry Dock Co.

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Interesting Pacific-Coast Installations

Two Work-boats Equipped with the New Frisco-Standard Oil-Engine

No internal-combustion marine-engine could have a better reputation in its particular sphere than the Frisco-Standard engine manufactured by the Standard Gas Engine Co. of Oakland, Calif. For many years this engine, operating on gasoline and distillate, has powered hundreds of commercial and pleasure craft on many shores and on the deep sea, installations on the Pacific coast of this country being exceedingly impressive both in number and character.

For a considerable time this company has noted the gradually increasing use of the heavier oils as fuel and has kept pace with progress by aggressively introducing into the work-boat market a heavy-oil engine which is by no means experimental, as it is being built under license from an established design. In order to make certain that "Frisco-Standard" reputation would be upheld and that immediate satisfactory service would be given the Standard Gas Engine Co. adopted this plan instead of developing an entirely new engine, and is now manufacturing an oil-engine similar to a surface-ignition engine which has been in successful operation for fifteen years. The Standard engineers, of course, made slight developments and modifications considered advisable by reason of their knowledge of the local field especially. It is not surprising, then, that the announcement of this new Frisco-Standard product should result in immediate orders being placed.

In our August issue on page 625 was mentioned the fact that Capt. Roy Lillico of the Lillico Tug & Barge Co. of Seattle, Wash., which operates a fleet of such craft, had made a trip down the West coast investigating oil-engines. For the purpose of installing this power in some of their fleet. His choice has been this new Frisco-Standard oil engine. A 150 h.p. four-cylinder engine has been purchased and will be installed on the tug LILLICO No. 20, which is an ex-Government tug which the Lillico company uses for outside towing. When this installation has been completed MOTORSHIP hopes to publish an article giving complete details of the installation and service-data.

Halibut-fishing out of Seattle is one of the big industries of that city and one of the leading concerns is the Pacific Fishing & Trading Co. Their schooner SEYMOUR is to be equipped with a four-cylinder 100 h.p. Frisco Standard oil-engine which will enable her to maintain schedule and make port at the most favorable turn of the market. For seaworthiness and ability to carry large cargoes of fish in heavy weather these halibut-schooners of the Pacific have earned a reputation rivalling that of the Gloucesterman. We expect to cover the details of this installation when same has been completed.

POSSIBILITIES OF THE USE OF HEAVY-OIL ENGINES IN AIRCRAFT

ALL existing aircraft engines suffer from the serious disadvantage that they can only be run with light oils, which are costly, and which, by their low flash point and high inflammability, greatly increase the risks of flying and cause fatalities in many accidents which would not be serious were it not for the fire caused by damage to the fuel tank. For commercial air services, in which safety is of the greatest importance, the development of engines capable of using a fuel of high flash point is highly desirable.

Kerosene may, of course, be used in the standard petrol engine, with no alteration except the addition of a vaporizer; its use, however, reduces the power and increases the weight of the engine, and results in very little reduction in the fire danger. We must then turn to the high-compression oil-engine of the Diesel or near-Diesel type in order to reduce our fire danger to the minimum. Hitherto, it has been generally considered that engines of the above type are essentially heavy, and therefore, unsuitable for aircraft. This is, however, a fallacy, as, given the same revolution speed, the weight per horse power of an engine depends primarily on the ratio of maximum pressure occurring in the cylinder, to the mean-effective-pressure. This ratio need be no higher in the high compression heavy-oil engine, than in the gasoline engine, so the only problem remaining, is to obtain good combustion of the fuel injected into the cylinder, in an engine running at a speed of about 1500 revolutions per minute.

In gasolene engines for aircraft, the four-stroke cycle has been almost universally adopted, because of the poor economy of the two-stroke engine, which wastes much of its fuel, by loss of the fresh mixture through the exhaust ports during the scavenging period. With the heavy-oil engine, the two-stroke cycle does not suffer from this disadvantage, as scavenging is, of course, carried out with air instead of with a mixture: We are thus able to obtain the great advantages due to the simplicity of the two stroke, and to its lighter weight per horse power, by the adoption of the heavy oil type of engine, and moreover, we remove two of the most fruitful causes of trouble with aircraft engines, namely, valves and electric ignition, in their place substituting only a comparatively simple fuel injection system, which, in the author's opinion, can be made absolutely reliable. A further great advantage of the Diesel or near-Diesel type, is that due to its higher thermal efficiency and corresponding lower fuel consumption, an aeroplane or airship will be able to cover the same distance on less weight of fuel, thus leaving more surplus carrying capacity for paying cargo.

We can now consider the type of engine most suitable for the work that is to be done. The correct Diesel cycle with a constant-pressure combustion, would be very difficult to operate at a high revolution speed, and the air-compressor used for fuel injection would have to be small, and would be a serious source of trouble and unreliability. On the other hand, the surface-ignition, or hot bulb type of engine, would be inconvenient for starting, and the necessity of the use of blow lamps, or other means of heating the vaporizer, would make it almost impossible to stop and restart the engine while flying. It would appear, then, that a mixed cycle with part of the combustion at constant volume, and part at approximately constant pressure, would be desirable. Such a cycle is used in both the Doxford and the Vickers engines, in which the compression pressure is about 360 lbs. per square inch, and the maximum pressure is about 500 lbs. per square inch. Both of these engines use "solid-injection" and so require no compressed air, during the normal running of the engine, an essential point in an aircraft engine, but the fuel injection system used, is, in neither case, suitable for application to a very high speed engine.

A type of fuel injection proposed by Dr. Low some years ago, is worthy of consideration, although it has serious disadvantages from some points of view. This system, which the author believes to have been successfully tested, was to provide the engine with a very small boiler, in which heavy oil was vaporized at a pressure considerably higher than the compression pressure of the engine. The fuel vapor was discharged into the cylinder through a mechanically operated fuel valve, as in the usual Diesel engine. Dr. Low thus overcame the difficulty of the very small fuel pumps that would have been necessary for an engine (about 3" and 4") such as that with which he was experimenting. This system, while it has undoubted advantages, is inconvenient because of the time necessary for raising the boiler pressure to the required figure before the engine is started, and it will further be difficult to so regulate the fuel pump, that there is no danger of the boiler running dry, and so becoming damaged through overheating; there will be some wastage of fuel in the heating of the boiler, thus somewhat reducing the economy of the engine.

In the author's opinion, a system of fuel injection on the following lines, should allow the necessary speed (i.e. about 1500 r.p.m.) and will be quite reliable. The supply of fuel would be controlled by a variable stroke pump, delivering fuel to an automatic valve in the cylinder head designed to open at about 1500 lbs. pressure. (The exact pressure for best combustion would have to be determined by experiment.) For such a pressure, the fuel pumps would have to be provided with a very tightly packed gland, so it would be necessary to provide a cam operating the pump positively on both discharge and suction strokes instead of a spring return as is usually used with cam operated mechanism. The pump stroke would take place in two periods; 1. during the compression stroke of the engine, a sufficient quantity of fuel would be delivered to raise the pressure to about 450 lbs. by explosion at the top of the stroke. This would raise the temperature enough to assure the good combustion of the remainder of the fuel which would be injected during the period of from top dead centre to 30° or 40° past.

The above outlines the general scheme of fuel injection proposed by the author; the details are simply a matter of drawing office work, and experiment with a completed engine.

EDITORIAL FOREWORD

As there is no other magazine devoted to heavy-oil engines, MOTORSHIP from time to time will touch upon the development of this class of power for ships-of-the-air, particularly as the tendency is to develop big sea-planes or flying-boats for commercial work. In an early issue we hope to give details of the excellent work along this line accomplished by the U. S. Government.

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The Diesel Engine No Longer a Mystery

Why the Shipowner Should Place Complete Confidence in the Oil-Engine's Reliability as a Merchant-Vessel's Propulsive Power

By A DIESEL-ENGINE CONSTRUCTOR

THOSE of us who have been connected with the development of Diesel-engines for the past ten years are thoroughly convinced of the suitability and numerous advantages of this system of propulsive power, and naturally are greatly interested in every addition to the rapidly increasing motorship fleet, and note with satisfaction the reliable operation in service.

We have done our best to demonstrate and convince the shipowner of the superiority and the benefits that are derived from a Diesel installation, yet there is an atmosphere of pessimism among certain classes of shipping interests. After many interviews with certain business men, I have noticed that the delay in adopting the Diesel-engine as a unit of power, is mainly due to lack of confidence in the reliability and durability of the Diesel drive. Is this lack of confidence due to lack of knowledge of the latest development in internal-combustion machinery? Is it based on the records of the past performances of some of our earlier installations? Or has the shipping interest failed to properly read MOTORSHIP, thereby losing an opportunity to be kept informed of the wonderful benefits that are derived from the up-to-date Diesel installation?

Having for ten years supervised the construction of approximately 40,000 I.H.P. of Diesel machinery, consisting of two-cycle and four-cycle, slow-speed as well as high-speed, marine engines, allow me to state for the benefit of the doubtful that—

(1) The up-to-date Diesel-engine is no longer a mystery and is as reliable as the steam engine.

(2) With proper care in operating it will outlast the hull of its ship.

If the above are facts (which I am perfectly convinced they are, due to practical experience), then why should the average shipowner be afraid to invest in a power-unit that is bound to take the place of all steam-plants in the near future?

We will now analyze the first fact, "That the Diesel-engine is no longer a mystery and is as reliable as the steam engine." Up to a few years ago the Diesel-engine was somewhat of a novelty. The operator of a Diesel installation took pride to impress the visitor with his new wonder. He would point out to him all the intricate parts of the machine. The visitor naturally would become bewildered and would leave the plant with the impression that the engine was too complicated; that his investment on a unit that was to him a mystery would require him to take a big chance. Whenever a break-down compelled the stopping of the machinery the public was always informed that the fault was due to too complicated mechanisms. As a rule the designer or the engineer never admitted the responsibility, which, of course, is natural. This atmosphere of mystery on the part of the builder and the operator had a good deal to do with the slow adoption of Diesel-engines for motive power.

Now that the manufacturers of internal-combustion machinery have learned their lesson through practical experience, there are designs of Diesel-engines that, as far as reliability and durability are concerned, due to better material and workmanship, are more than the equal of a steam-engine.

The engineer of a Diesel installation has also learned his lesson. A few years ago he was very much inclined to blame all the break-downs on the engine, and would say, "Can't help it." "Too complicated" "Something has to go sooner or later." Therefore, everyone took it as a matter of fact. Today everyone who has watched the development of the Diesel-engine knows that any number of young, capable engineers who have had a good training on the test stand in the shops where Diesel machinery is being manufactured, are on the market waiting for an opportunity to prove to their employers that almost any make of Diesel-engine can be made to operate to the satisfaction of its owner. The engineer who has a tendency to create an atmosphere of mystery and is inclined to blame his engines for the majority of breakdowns, is not, in my opinion, the man for the job.

During the past two years I have been fortunate to be detailed to test-stand work on some 4-cycle Diesel-engines, ranging from 1,200 B.H.P. up to 3,000 B.H.P.

An up-to-date Diesel engine with ten cylinders, direct reversible, 4-cycle, bore 20⅞", stroke 20⅞", was operated successfully for about eight months at 390 R.P.M. At times the engine was loaded so that the indicator-cards would show as high as 142 pounds M.I.P. and 1,200 degrees F. temperature at the exhaust valves. This submarine engine, built of cast steel, was rated at 3,000 B.H.P. and weighed eighty tons. These engines can be built for commercial use, both land and marine installations.

What a pity that someone does not take more advantage of this latest development in Diesel engineering. These engines can be built by American workmen and are guaranteed, as was proven on the stand, to be superior to any steam-engine as far as maneuvering qualities, reliability and durability are concerned. The speed ranges from 20 R.P.M. to 390 R.P.M. Outside of two slight critical points in the range of operation, I am sincerely convinced that with proper care, an installation of this type is absolutely foolproof. What a splendid equipment for a stationary power-plant, a direct-connected reversible marine installation, or an electric-drive aboard ship. These engines can be maneuvered at will in ten seconds from full-speed ahead to full-speed astern and have forced lubrication throughout. There is no need of hand lubrication.

The next fact is "That with proper care in operating it will outlast the hull of its ship." We all know that there are reliable Diesel-engines varying in weight from 50 lb. a H.P. to 400 lb. a H.P. Some are low speed, others high speed. However, type and size is left to the buyer to suit his ship or plant.

We also know that there are some-well-designed Diesel-engines built with the best material obtainable and with nothing but the best workmanship. Of course, the price of these units per H.P. is rather high. Some others which are inferior in design and workmanship can be purchased at a lower price per H.P. The choice is left to the individual buyer. Nevertheless they are all guaranteed to operate.

Now comes the secret for success: I must emphasize that the success or failure of any Diesel installation depends entirely on the personnel entrusted to its operation. This I have found out through personal observation. It is, therefore, up to the owner (a) to select his operating chiefs; (b) have them detailed in the factory where the engine is being built so that they can familiarize themselves with every item. Also to be instructed on its operation and to learn the weak points, if there are any. (c) The operating personnel must be composed of men who are thorough mechanics and who have enough technical knowledge to be able to bring and keep the engines to the maximum of their efficiency and economy.

It is known that all internal-combustion engines are subject to shocks. These shocks are very pronounced and are greatly aggravated if the engineer persists in running his engines out of tune. These shocks will create a torsional vibration, which in time will crystallize and weaken parts of the machinery, creating a serious breakdown. Therefore, it is essential to the success of the installation that the engineer be selected among the ones who are thoroughly capable of avoiding any operation that might be a detriment to the machinery.

Bear in mind the fact that some Diesel-engine builders have a tendency to rate their units high. This naturally is a financial benefit, due to the fact that generally engines are sold at per B.H.P. Nevertheless it is a mistake, for whereas an engine will develop a high power on the test-stand in the works under a high piston-speed for a given time with the best care from experienced works engineers, it is no guarantee that the same engine will develop the same power in actual service for very long. Therefore, let the owner see that his engineers are instructed not to exceed a speed and power beyond the point of common sense.

By living up to these fundamental points so as to give the machinery a living chance, there should be no doubt that with the proper care and maintenance, consisting of regular routine overhauling of valves, etc., any up-to-date Diesel installation will give perfect service, both in reliability as well as durability, and will outlast the hull of its ship.

E. DELBOSC.

The new German built single-screw A. E. G.—Burmeister & Wain Diesel-driven tanker "Julius Schindler," which recently visited the Delaware River

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Interesting Notes and News from Everywhere

CONSTRUCTION of Diesel marine-engines is being carried out by the Danziger Werft, Danzig.

To the order of the Antwerp Municipality a 63′ 6″ oil-engined ferry is being built by the Werft Gusto, Schiedam, Holland.

The new large Diesel-driven passenger motor-liner ADDA will shortly be ready for service. She is a sister to the M.S. ABBA.

Work has started on the second of the Pacific-Werkspoor-G. E. C. Diesel-electric ferries for the Golden Gate service.

Sulzer Diesel engines are installed in the first submarine constructed for Norway, which was recently finished.

Freight and passenger motorship service is to be established on the Yellow River, between Tsinan and Chengchau, Honan, China.

Twin 350 b.h.p. Benz Diesel-engines were installed in the German motorship AEGIR when recently converted to motor power.

A new motorship building yard is being laid out at Graasten, Northern Schleswig, by Rohde Bros. of Grenaa.

While on test the 3,000 i.h.p. Doxford opposed-piston oil-engine of the motorship EKNAREN indicated as high as 4,300 i.h.p.

C. Allan Hancock's new Winton-Westinghouse Diesel-electric 125-ft. yacht, VALERO II, was recently launched at Los Angeles, Calif.

LOCH GOIL, the second of the three 14,000-ton d. w. motorships for the Royal Mail Steam Packet Co., was launched by Harland & Wolff on August 24th.

SONA, Lord Dunraven's new twin-screw motor-yacht, ran trials during July. She is propelled by twin Vickers-Petters oil-engines of 450 shaft h.p. each.

DALGOMA will be the name of the 6,000 shaft h.p. Stephens-Sulzer Diesel-engined motorship now building for the British India Steam Navigation Company by Alex. Stephens & Sons.

According to reports, a new Diesel-engine construction plant is to be erected at Fifth St. on the water front at Gloucester, N. J., by Lieut. James H. McNally.

One of the Shipping Board's Eastern class of freighters will be purchased by the Luckenbach Line of New York and converted to direct Diesel drive.

While in the docks at Hull recently a serious fire started in the cargo of rum in the hold of the Danish motorship SIAM. The vessel was saved.

The Armstrong-Sulzer Diesel-driven tanker, CONDE DE CHURRUCA, recently arrived at Los Angeles under charter to Royal Dutch-Shell interests.

Work is progressing on the construction of the twin 2,500 shaft h.p. Fullagar Diesel marine engine at the works of John Brown & Co., Clydebank.

Twin 120 b.h.p. Kahlenburg surface-ignition oil-engines will propel the new 120 ft. passenger-and-cargo vessel to be built by the Murnon Shipbuilding Co., Mobile, Ala., from designs by Cox & Stevens.

The new 7,400-ton motorship LINNELL of the Lamport & Holt Line arrived at Boston from South America two days ahead of her schedule, due to the excellent time made on the voyage.

Three Pacific-Werkspoor marine-type Diesel engines of 825 shaft h.p. each have been purchased by Frank Lynch, of the Benson Lumber Co., San Diego, Cal., from the U. S. Shipping Board Emergency Fleet Corp.

The new airless-injection Hesselman engine, which system was first described in MOTORSHIP, will be manufactured in Sweden by the Aktiebolaget Bofors, a well known munition and steel plant.

Trials were run on Aug. 10th of the new German 800-ton motor auxiliary EMMA BIESTERFELD, built for the Reederei Wm. Biesterfeld, Hamburg, at the Janssen & Schmilinsky shipyard, in the same city.

ODENWELD is the name of one of the 8,000 ton motorships building at the Deutsche Werft for the Hamburg-America Line. Twin A. E. G.-Burmeister & Wain Diesel engines aggregating 3,100 i.h.p. are being installed.

A ferry vessel is to be built to run between Anacortes, Wash., and Victoria, B. C. It is almost certain that Diesel power will be installed, and the make of engines will be selected shortly.

A 7,600-ton deadweight motorship is building at the Akers Yard, Kristiania, Norway,

The Burmeister & Wain engined coastwise motorship "Batavia"

for the Norway-Pacific Line. Refrigerator space for carrying fruits, meats, fish, etc., is being arranged.

The Norwegian-Mexican Gulf Line's (Wilhelm Wilhelmsen) new 10,000-ton deadweight motorship TENNESSEE, illustrated on page 688 of our last issue, was launched on Aug. 1st at the Burmeister & Wain shipyard.

The advertisement for Technical Books on another page in this issue of MOTORSHIP has just been revised, and practically all books listed are now in stock. Maybe you need some of these useful books.

The converted German warships ADOLF SOMMERFELD and FLORA SOMMERFELD have been unsuccessful owing to the cargo capacity being too small compared with the loaded displacement. They have been sold for dismantling.

In a recent issue the *Journal of Commerce* of Liverpool states that if the latest returns of the output of eleven of the largest British engineering firms for 1921 can be taken as a cri terion, the days of the steam-turbine for marine propulsion are numbered.

A license to construct the Nobel two-cycle type merchant marine Diesel oil-engine has been acquired by Mirrless, Bickerton & Day, Stockton, England. The first description of this remarkable new engine was published in the December, 1921, issue of MOTORSHIP.

Among large auxiliary sailing-ships in service is the AUGUSTELLA, a four-masted bark of 3,500 tons, propelled by twin 500 shaft h.p. Ansaldo-San-Giorgio Diesel engines. Her owners are the Societa Italia di Navigazione. She was converted last year.

Twin 500-shaft-h.p. Kromhout surface-ignition oil-engines will be installed in a large passenger ferry-vessel to be placed in service by the Netherlands State Railways. The vessel will be 210 feet long by 31½ feet breadth, and will have a capacity of nearly 1,000 passengers.

If any of our New York readers has a spare copy of the August, 1922, issue of MOTORSHIP we will be glad if he will send same to Mr. G. W. Sterling, Pres., Foreign Transport & Mercantile Corp., 8 Bridge St., New York City. In order to avoid duplication we suggest that before sending the copy Mr. Sterling be telephoned "Bowling Green 5636."

Trials were recently run at an Italian shipyard of the new 4,700-ton gross concrete auxiliary schooner PERSEVERANZA, recently launched at Lavagna, built to the order of the Societa Anonima Navi Italiane Cemento Armata. In addition to her sail power she has twin Tosi 4-cycle Diesel engines of 180 shaft h.p. each.

Some time ago the oil-engined auxiliary sailing vessel HJELTENAES was put in service. After her first voyage from Hamburg to St. Thomas, V. I., she was unfortunate and only two long and slow trips were made, on which the loading and discharging expenses were 89,231 kroner, or one-third of the vessel's gross freight. Following the initial voyage the motor was removed and sold at Hamburg for 82,000 marks. The ship has since been lost.

A series of four "Who's Who in Shipping" have been produced by the *Journal of Commerce*, Liverpool, England, entitled "Liverpool Shipping," "London Shipping," "Glasgow Shipping" and "North East Coast Shipping." These books are in compact form and give full information regarding shipbuilders, engine-builders, shipowners, ship brokers, etc., in their respective districts and should be found highly useful.

Special significance is attached to the recent production record of 5,232,051 piston-rings made by the Piston Ring Co. of Muskegon, Mich., during two consecutive working months. Although their plant is the largest exclusive piston-ring factory in the world, with its capacity of 12,000 rings per working hour, there is every reason to believe that further expansion will soon be necessary to keep abreast of the steadily increasing demand. The company specializes in large rings for Diesel and other oil-engines.

OUR NEW ADDRESS

Between Sept. 25 and 30 the Head Offices of MOTORSHIP will be moved to 27 Pearl St., New York.

In the Heart of the Shipping District

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Our Readers' Opinion

(The publication of letters does not necessarily imply Editorial endorsement of opinions expressed)

HUGO MOREN ANSWERS ENGINEER COWSILL

The Editor of MOTORSHIP:

In your July issue Wm. A. Cowsill, in charge of the Vickers-engined M. S. NARRAGANSETT points out something which appears not to have existed when the ship in question ran ashore.

When a ship at speed enters shallow and narrow water a heavy back-stream sets up and perhaps the engine speed increases for a moment until the ship speed has settled down to suit the new conditions. Meanwhile the engine slows down below the normal number of revolutions because of greater frictional resistance everywhere in the water—and if the ship stops on shore the engine slows down still further for the same reasons.

If the Chief whom Mr. Cowsill speaks about had been present on the ship in question, he would not have had time enough to be out of his "bunk" and down below even for that difference of 22 revolutions before the ship was stopped ashore.

If I understand Mr. Cowsill right, he has misunderstood me. The grooving of that inlet cam occured on an auxiliary engine. These engines have no pushrods but there is a good clearance between the roller and the cam. In that particular engine the piston touched the inlet valve and therefore the heads of old inlet valves had been shortened about one-eighth inch a long time before. A new spare valve used had not been altered and it caused the grooving.

The refrigerating set used was not in first class order, but the high temperature of the cooling-water (about 85° F) made things worse.

Re exhaust valves, I have pointed out in my article that water cooling of the exhaust valves proper would spare immense work on such valves when using slow burning asphaltic oils.

Mr. Cowsill's remarks about "his" exhaust valves are of a very interesting nature, and they confirm my opinion.

It would be very interesting to know the number of engine-room crew in M. S. NARRAGANSETT. I hope you will receive some more information *re* the performance of Two-Stroke Engines, especially Sulzer engines.

I am a strong believer in the very simple "Still" Engine.

HUGO MORÉN.

Birmingham, July 12th, 1922.

PISTON PIN LUBRICATION

The Editor of MOTORSHIP:

I have a party who, for a long time, has been interested in buying a hot-bulb marine type-oil-engine and with whom I have discussed, as far as it has been possible for we simple amateurs, the advantages and disadvantages of the various European stationary motors around this part. We have come to the conclusion that most every one of them has given trouble down here in regards to the proper lubrication of the piston pin bearing which has been the constant source of trouble with all of the crude-oil motors of the hot-bulb type that have come to this country. We presume this is due to working with Asphalt-base crudes that leave in the cylinders a thick pasty compound (residues) that probably plugs the lubricating holes. This is the only kind of fuel available down here so far. In other instances, the residue forms small "stones" that act as though they were made of the best emery known.

My friend and I have figured theoretically some plan to eliminate this trouble and have a dependable way of lubricating the pin bearing, and would be willing to discuss this point with any one interested, or we would like to be placed in touch with a marine motor manufacturer that has already solved this problem.

ARROBA GARAYCOA.

Commission Agent,
P. O. Box 82,
Guayaquil-Ecuador, So. America.

EXPERT OPINION

The Editor of MOTORSHIP:

Hearty congratulations on the excellence of your magazine and with best wishes for its future continued success.

E. NIBBS.

Chief-Engineer,
New London Ship & Engine Co.,
Electric Boat Co.,
Groton, Conn.

A VOICE FROM THE PACIFIC

The Editor of MOTORSHIP:

From an impartial standpoint MOTORSHIP is far superior to foreign publications, simply it speaks the language and represents the voice of America. This is not to imply that any praise is intended, but merely as a matter of fact. Every issue of MOTORSHIP is a contribution of highest literary value to the field of internal combustion engineering. The language is plain, and it may be considered the only technical paper of its kind without criticism of serious nature.

J. R. LA MARCHE, M. E.

Western Technical Book Co., Thompson Bldg., Seattle, Wash.

THIS LETTER SPEAKS FOR ITSELF

The Editor of MOTORSHIP:

I cancelled my subscription to MOTORSHIP about May 1st, but I find that there was lots of information in it that I miss very much.

People not in touch with shipping and the present situation have very little chance to get at the facts of what should be done, and as the shipping business of this country is at the present time of the greatest importance I wish to have information that I believe is correct and this your paper supplies.

Please enter my subscription to begin with the May issue, and enclosed find M. O. for $3.00 to pay for same.

A. W. F. BROWN,
Supt. of Water Dept., City of Fitchburg, Mass.

WANTS TO BUILD A CONCRETE YACHT

August 24, 1922.

The Editor of MOTORSHIP:

I have read your article in July MOTORSHIP about the successful concrete-ships, and I have been planning for some time to build a tug-shaped reinforced-concrete yacht with comfort and seaworthiness instead of speed. I intended to cast the ribs separately, setting them up in line with a wood form between them and pour the concrete all in one operation.

I had planned to build the boat about 75 or 80 feet long with a beam of about 16 or 17 feet, and a draft of 8 or 9 feet, with a hull 3½ in. thick for extra strength. Have you any tug lines that I can look over or do you know where I can get them?

E. R. HANER.

Flint, Mich.

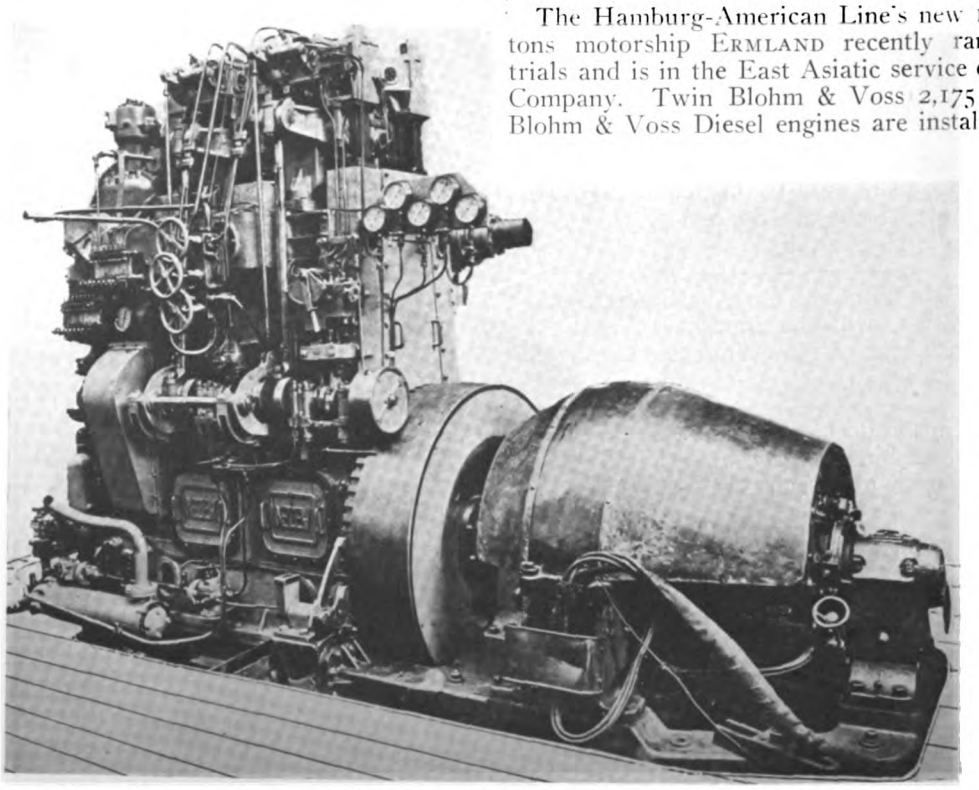
[We suggest that you communicate with Col. P. M. Anderson, Southern Bldg., Washington, D. C., who built the U. S. War Dept.'s fleet of concrete vessels.—*Editor.*]

SOME NEW MOTORSHIPS

The new 8,000 tons motorship TIRADENTES will arrive in New York early in November, consigned to the Kerr Line.

ISIS, the Kosmos Line's new motorship, has run a successful 24 hours' trial in the North Sea and is now loading in Germany for the West Coast of South America. She was built by the Deutsche Werft and is propelled by twin 1,550 i.h.p. A.E.G.-Burmeister & Wain Diesel engines. Speed, 12½ knots. She was illustrated in our June issue.

The Hamburg-American Line's new 10,000 tons motorship ERMLAND recently ran her trials and is in the East Asiatic service of the Company. Twin Blohm & Voss 2,175 i.h.p. Blohm & Voss Diesel engines are installed.



New design of two-cycle double-acting Diesel engine built by the North British Diesel Engine Co. It is of 240 b.h.p.; but an engine of 2,000 shaft h.p. is under construction. The cylinder reciprocates synchronously with the pistons, but with a shorter stroke

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CURRENT REVIEWS

Notes and Sketches on Marine Diesel Oil Engines. A Manual of Marine Oil Engine Practice. By J. W. M. Sothern. 400 pages, 230 illustrations. Published by James Munro & Co., Ltd., Glasgow, Scotland, 1922. What "Verbal Notes and Sketches for Marine Engineer Officers" is to operating steam-engineers we predict this new work by Sothern will mean to Diesel-engineers. Not only are all of the various types of Diesel engines illustrated by half-tones and diagrams, but there are numerous plates with various parts numbered and keyed so that even an uninformed reader can readily learn the details of construction. Drawing on many sources the author has produced a book which is exceptionally complete both as to text and illustration.

General definitions and terms of Diesel-engine nomenclature are explained as well as indicator-diagrams; there are also interesting chapters on testing fuel-oils, calculations by the Metric system, auxiliary gears and Diesel, semi-Diesel hot-bulb, petrol and paraffin auxiliary engines. About half the book is devoted to practical operation of Diesel-engines, troubles, their causes and remedies, etc. We do not believe that either the designing or the operating engineer should be without one of these books close to hand.

The Bull-dog Oil Engine. Catalogue of Bates and Edmonds Motor Co., Lansing, Mich. 12 pages. Readers of MOTORSHIP will be interested in learning of the salient features of this Hvid type oil-engine manufactured by this well-known firm in the field of stationary internal-combustion engines. This catalogue describes their stationary type of oil-engine built in 6 and 12 h.p. Simple and easily understood this engine should find a real place in the marine field when the manufacture of this type is entered into. Their marine oil-engine is nearly ready.

"Western" Diesel Engines. Stationary and Marine Types. Catalogue of the Western Machinery Co., Los Angeles, Cal. 46 pages, well illustrated. Much of the care with which engines are produced is reflected in the literature of the manufacturer and in the case of the Western Machinery Co., we are glad to note that their catalogue shows every indication of being produced with care, the greater portion being devoted to the stationary type. Blueprint fac-similes of their Diesel-engines, together with numerous illustrations of parts and complete engines, give quite complete data on both types, as the marine type is exactly the same in design and operation as the stationary engine, with the addition of a reverse-gear of the manufacturers' design. We believe that our readers should become better acquainted with this four-cycle airless-injection Diesel-engine by perusal of this catalogue

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Moteurs Diesel. Brochure (in French) issued by Schneider & Cie., Paris. 24 pages, well illustrated. Undoubtedly one of the greatest engineering organizations of Europe is Schneider & Cie., one hundred years old, producing as it does machinery for every industrial purpose, as well as furnishing France with a tremendous volume of ordnance. Their Diesel-engines have been well developed and perfected and a reading of this brochure enables one to understand the care which has been given to their production. Schneider & Co's subsidiary in the United States is the Framerican Industrial Development Corp. of New York City, whom, it will be remembered, recently floated with success twelve million dollars of industrial bonds in this country.

Two Years Before the Mast, by Richard H. Dana, Jr. Publishers: Macmillan Co., N. Y. Price, $1.50. This deep-water classic is so well known that criticism would be superfluous. It is one of those stories of life and adventure at sea which will never die. Macmillans, however, are to be congratulated for getting out an excellent illustrated edition of this great nautical diary. The well-known marine artist, Charles Pears, has made about twenty color plates illustrating the text, and they are fully in keeping with the story and serve to lend more action and color to it.

Atlas-Imperial Mechanical-Injection Diesel-Engines. Catalogue of the Atlas-Imperial Engine Co., Oakland, Cal. 32 pages. We have read with considerable interest this attractive catalogue lately issued by this well-known engine manufacturer, featuring Diesel-engines of 55 to 300 h.p. as well as auxiliary Diesel generating-sets, air-compressors and drag-line engines for dredges, excavators, etc. The solid or mechanical-injection principle for Diesel-engines has usually been applied to engines of larger power, but the Atlas-Imperial Engine Co. has produced a Diesel-engine using this principle in low powers, which are illustrated in their catalogue. Full information is given of each engine and typical vessels in which they are installed are also illustrated.

"Taylor Principle" Oil Engine. Brochure issued by the Taylor Machine Co., Chicago, Ill., 16 pages, also 12 page supplement containing specifications of "Taylor Principle" stationary and marine oil-engines from 5 to 6,000 h.p. designed by J. Leonard Taylor. This brochure pictures this two-cycle engine as the "successor of the Diesel-engine" and describes the various features, such as the injection-valve, fuel-atomizer, stepped-piston, air-control for scavenging, etc., which make this airless-injection engine both economical and reliable. It is claimed that it can be operated by inexperienced men on very low degree fuel-oil, and dimensions and fuel-consumption figures are included for engines up to 6,000 h.p., which it will be noted is about double that of any present single marine Diesel-engine in marine service. In many features of design this engine resembles the Southwark-Harris marine Diesel-engine, that was built from designs by Leonard B. Harris.

Brassey's Naval and Shipping Annua. 1921-2. Edited by Alexander Richardson and Archibald Hurd. William Clowes and Sons, Ltd., London. 486 pages. Illustrated. The thirty-third annual appearance of this important reference volume has been greeted with an appreciation of its value by naval and shipping men. Never before has this book covered such a wide scope. The naval section with appendix is fascinating reading as well as invaluable data which is unobtainable in any other work. Leading authorities of various navies and others have contributed toward making this section exceedingly comprehensive, not only embracing every type of fighting craft in all the navies, but discussing all the various phases of naval warfare, lessons of the World War, etc. This naval section consists of fifteen chapters.

The merchant-shipping section is composed of twelve chapters dealing with the status of the world's mercantile marine, freights, the cost of speed, a study of propelling machinery, studies of Japanese and of German shipping and shipbuilding, standard ships, fuel-oil resources, commercial airships, the importance of coastal shipping, etc. In an appendix to this section are given lists of shipowners, shipbuilders, marine engineers, ship repairers, benevolent, naval, shipping, and technical associations and organizations, tables showing the development of trade, marine propelling machinery, motorships and oil-fuel, etc.

In the opening chapter "The World's Mercantile Marine," Sir Westcott S. Abell, Chief Surveyor, Lloyd's Register of Shipping, says: "Other things being equal, one ton of oil utilized in Diesel-engines drives a vessel three times as far as one ton of coal burnt in the ordinary way under boilers, while if oil be used as fuel with water-tube boilers and geared-turbine engines, the arrangement is twice as efficient as when coal is the source of energy. Besides this increased efficiency of power production, there are other advantages to be derived owing to the ease of bunkering, the avoidance of trimming at sea, and the reduction of personnel for firing and supervision; while to some extent there may be a saving in weight (including fuel for the voyage) and a gain in space available for cargo, since the oil fuel can be carried in spaces, such as double bottoms, which cannot be used either for coal or cargo. It is believed that recent experience has clearly indicated that Diesel-engined ships can be operated under present conditions with reasonable profit at a time when a large proportion of the world's tonnage has had to be temporarily laid aside, and there appears to be no doubt that, in view of the mechanical and economical advantages in the use of oil as fuel, a considerable proportion of the replace tonnage of the near future will be adapted for the new fuel."

James Richardson contributes a chapter on "The Propelling Machinery in the Mercantile Marine," outlining briefly the principles and development of the various sources of power, i. e., the steam reciprocating-engine, the steam-turbine, mechanical gearing, turbine-electric drive, transformers, boilers and oil-firing, and the Diesel-engine and Diesel-electric power. To the reader vitally interested in the Diesel-engine or to the steam-engineer anxious to obtain a brief yet comprehensive view of the various types, developments and features of Diesel and oil-engines this chapter will prove well worth serious reading. In many chapters of the "Review" reference is made to the advantages of the Diesel-engine.

Our American readers will be interested to know that Brassey's Naval and Shipping Annual may be obtained through Brentanos, New York City or through the office of MOTORSHIP. Price $8.25 plus postage.

MAIDEN VOYAGE OF MOTOR-TANKER "OLJAREN"

Leaving Göteborg, Sweden, in ballast on June 4th, last, two days after her trials, the new Götaverken built and engined tanker OLJAREN arrived at Port Arthur, Texas, twenty days later. She loaded 7,200 tons of gas-oil and sailed from that port on June 26th, arriving in Svolvaer, Norway, on July 17, where 3,000 tons of oil was discharged. The OLJAREN then proceeded to Fredericia, Denmark, and discharged the balance of her cargo. The entire round trip, including to Denmark, occupied 1,220 hours, of which 1,075 were spent at sea.

Although the Burmeister & Wain type main engines are designed to develop 2,600 i.h.p., the power attained on the trials was 2,937 i.h.p. at 142 r.p.m. On the outward voyage the engines developed 2,402 i.h.p. at 128 r.p.m. and 2,493 i.h.p. at 133 r.p.m. With the ship loaded 2,552 i.h.p. was developed at 127 r.p.m. The fuel consumption was 9 metric tons in 24 hours and the mean speed 11.3 knots in ballast and 11.2 knots loaded.

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